

General Disclaimer

One or more of the Following Statements may affect this Document

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.
- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.
- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.
- This document is paginated as submitted by the original source.
- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

NASW-2884

~~DRA~~

SDT

(NASA-CR-153930) STS ANCILLARY EQUIPMENT
STUDY. USER REFERENCE BOOK (Aerospace
Corp., El Segundo, Calif.) 175 p
HC A08/MF A01

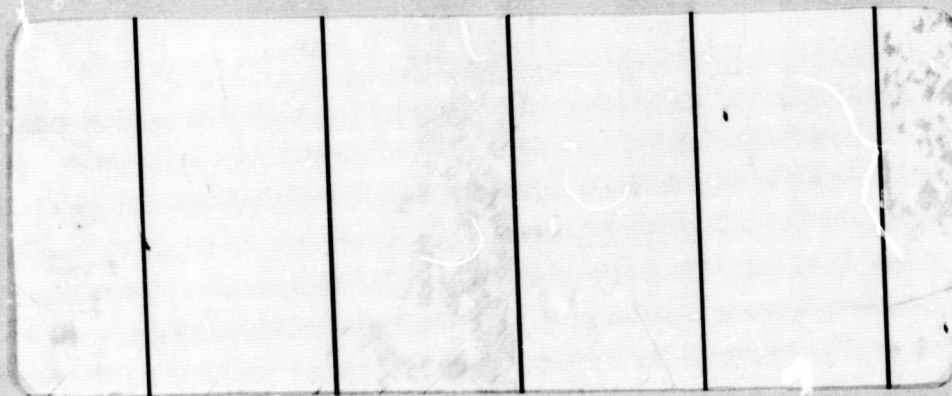
N77-28203

CSCL 22B

G3/16

Unclass

15043



THE AEROSPACE CORPORATION

STS ANCILLARY EQUIPMENT STUDY

USER REFERENCE BOOK

Prepared by
Advanced Mission Analysis Directorate
Advanced Orbital Systems Division

June 1977

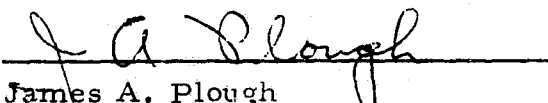
Systems Engineering Operations
The Aerospace Corporation
El Segundo, California

Prepared for
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Washington, D. C.

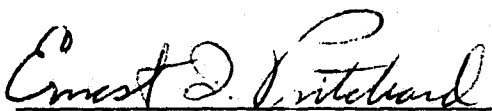
Contract No. NASW-2884

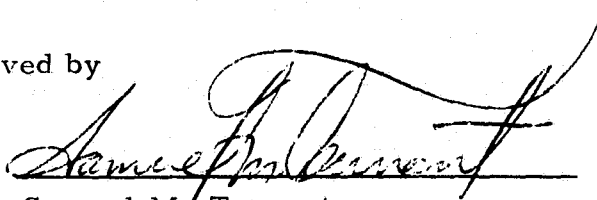
STS ANCILLARY EQUIPMENT STUDY
USER REFERENCE BOOK

Prepared by


James A. Plough
Staff Engineer
Advanced Mission Analysis Directorate

Approved by


Ernest I. Pritchard
Study 2.2 Director
Advanced Mission Analysis
Directorate
Advanced Orbital Systems Division


Samuel M. Tennant
General Manager
Advanced Orbital Systems Division
Systems Engineering Operations

CHANGE RECORD

ITEM	PAGE	DATE	DESCRIPTION OF CHANGE

ACKNOWLEDGEMENTS

Dr. Leo Werner, STS Operations, Office of Space Flight, NASA Headquarters directed the Ancillary Equipment Study for NASA. Many additional NASA personnel furnished information and guidance on the study, including:

Phillip E. Culbertson	Headquarters
James Bredt	Headquarters
Charles Hart	KSC
Jack Heberlig	JSC
James Prim	JSC
Carmin DeSanctis	MSFC
Hugh Gangl	MSFC
Rein Ise	MSFC
William Lucero	MSFC

PRECEDING PAGE BLANK NOT FILMED

ABBREVIATIONS

AFD	Aft Flight Deck
APPS	Auxiliary Payload Power Supply
ASPS	Annular Suspension and Pointing System
ATM	Apollo Telescope Mount
CCTV	Closed Circuit Television
C&D	Controls and Displays
CDH	Command and Data Handling
CITE	Cargo Integration Test Equipment
CRT	Cathode Ray Tube
C&W	Caution and Warning
DEU	Display Electronics Unit
DMSP	Defense Meteorological Satellite Project
DSP	Defense Support Program
ECU	Environmental Control Unit
EICDA	Electrical Isolation, Conditioning, and Distribution Assembly
EVA	Extravehicular Activity
FSC	Fleet Satellite Communications
FSK	Frequency Shift Keyed
FSS	Flight Support System
GCMS	Gas Chromatograph/Mass Spectrometer
GPS	Global Positioning System
I&C	Instrumentation and Communication
IECM	Induced Environment Contamination Monitor
IPS	Instrument Pointing System
IUS	Interim Upper Stage
IVE	Interface Verification Equipment

PRECEDING PAGE BLANK NOT FILMED

ABBREVIATIONS (CONT'D)

LOS	Line of Sight
MAAPS	Multi-Discipline Auxiliary Payload Power System
MDAC	McDonnell Douglas Astronautics Company
MDM	Multiplexer/Demultiplexer
MFDS	Multifunction Display System
MMC	Martin Marietta Corporation
MMSE	Multi-Use Mission Support Equipment
MMU	Manned Maneuvering Unit
MPC	Manual Pointing Controller
MSS	Mission Specialist Station
O&C	Operations and Checkout
OFT	Orbital Flight Test
OPF	Orbiter Processing Facility
PCM	Pulse Code Modulation
PCR	Payload Changeout Room
PSS	Payload Specialist Station
RAU	Remote Acquisition Unit
RI	Rockwell International
RIG	Rate Integrating Gyros
RMS	Remote Manipulator System
RTG	Radioisotope Thermoelectric Generator
SAEF	Spacecraft Assembly and Encapsulation Facility
SIPS	Small Instrument Pointing System
SSPD	Summarized NASA Payload Descriptions
SSUS	Solid Spinning Upper Stage
STP	Space Test Program
STS	Space Transportation System

ABBREVIATIONS (CONT'D)

TBD	To Be Determined
TDRS	Tracking and Data Relay Satellite
TGA	Trace Gas Analyzer
TP	Twisted Pair
TPS	Thermal Protection System
TSP	Twisted Shielded Pair
VAB	Vertical Assembly Building

CONTENTS

ACKNOWLEDGEMENTS	iv
ABBREVIATIONS	v
1. INTRODUCTION	1-1
2. FORMAT FOR ANCILLARY EQUIPMENT USER REFERENCE BOOK	2-1
3. ANCILLARY EQUIPMENT DATA FORMS	3-1
3-1. Ground Equipment	3-5
Launch Site Transportation System	3-6
Payload Canister	3-9
Transporter, Payload Canister	3-12
Payload Handling Fixture (Strong Back)	3-14
Environmental Conditioning Unit	3-16
Instrumentation and Communication Unit	3-18
Payload Canister Access Equipment - Horizontal	3-20
Launch Site Service Carts	3-22
Set, Hydrazine Service	3-24
Set, Instrument Gas, Service	3-26
Set, Liquid Helium, Service	3-28
Cart, Payload Purge	3-30
Set, Liquid Hydrogen, Service	3-32
Set, Liquid Nitrogen, Service	3-34
Set, Liquid Oxygen, Service	3-36
Multipurpose Work Stands, Access Platforms, and Slings	3-38
Access Platform, Spacecraft Assembly Stand	3-40
Sling Set, Multipurpose	3-42
Stand, Spacecraft Assembly, Vertical	3-44
Stand, Work, Payload Assembly/Test, Horizontal	3-46

	Cargo Integration Test Equipment	3-48
	Outsized Payload Transportation System	3-53
3.2	Spaceborne Equipment	3-55
	Pointing and Stabilization Systems	3-56
	Small Instrument Pointing System	3-58
	Annular Suspension and Pointing System	3-61
	Instrument Pointing System	3-65
	Electrical Cabling	3-69
	Automated Payload/IUS Cabling	3-72
	Automated Payload/Orbiter Cabling	3-75
	Contamination Monitoring	3-78
	Induced Environment Contamination Monitor	3-80
	Trace Gas Analyzer	3-84
	Manned Maneuvering Unit	3-92
	Auxiliary Power Systems	3-96
	Auxiliary Payload Power System	3-98
	Multi-Discipline Auxiliary Payload Power System	3-101
	Payload Specialist Station	3-105
	Radioisotope Thermoelectric Generator (RTG) Cooling Unit	3-113
	Second Ku-Band Antenna	3-116
	Common Cradle/Non-IUS Payloads	3-120
	Multi-Use Fluid Line Kits	3-124
	Umbilical Connector	3-127
	Avionics Equipment	3-132
	Multiplexer/Demultiplexer	3-134
	Electrical Isolation, Conditioning, and Distribution Assembly	3-136
	Dedicated Payload Command Recorder	3-139
	PCM Unit	3-146
	DC-DC Converter/Regulator	3-151
4.	REFERENCES	4-1

1. INTRODUCTION

This User Reference Book for NASA's use is a record of what is currently known about STS ancillary equipment. The data in this document are user-oriented and designed to eventually contain sufficient information so that a potential user would be able to evaluate whether he could use the described ancillary equipment or if he would need to design and fabricate a payload-unique item. The document also provides references that the user can use to obtain additional details and requirements to aid in his evaluation and decision.

The first document, in the series of two, is entitled "STS Ancillary Equipment Study Final Report." It describes the effort which resulted in this User Reference Book. Recommendations are made on keeping this reference book current and an approach to maintaining an equipment inventory. As this document goes to press, its future has not been settled.

2. FORMAT FOR ANCILLARY EQUIPMENT USER REFERENCE BOOK

The data form shown in Table 2-1 was derived with the potential user of ancillary equipment in mind. The data are intended for those potential users attempting to evaluate the equipment for use on his program rather than to build payload-unique equipment. A description of the information under each of the data headings is presented below.

1. Name of Item and Identifying Number

The name of the particular piece of ancillary equipment and an identifying number is presented. The identifying number may be an MMSE number (see References 6 and 8) or a drawing or part number (see item 11 below).

2. Equipment Description

This is a brief description of the item including its intended use and a sketch, outline drawing, or block diagram. This is presented to the user even if the item is conceptual and not hardware. A list of components is also helpful and included when the information is available. This description was obtained from one or more of the references in item 11 below.

3. Physical Characteristics

The size (dimensions or volume) and weight of the item are given. These characteristics were obtained from the references in item 11 below.

Table 2-1. User Reference Book Data Form

1.	Name of Item and Identifying Number
2.	Equipment Description
3.	Physical Characteristics
4.	Purpose and Intended Application
	a. Capability and Function
	b. What Types of Payloads
	c. What STS Elements are Involved
	d. Describe Interface Requirements
5.	Identification of First Potential User and Year of First Use
6.	Identify All Potential Users
7.	Estimate Flight Rate or Number Required
8.	Equipment Cost Estimate
	Development Schedule
9.	Potential Value of Equipment
10.	Status
11.	Reference(s) for Additional Data
12.	Contact

4. Purpose and Intended Application

a. Capability and Function

The actual or proposed capability and function (what can it do -- what are its limitations) are described. Included are specifications, schematics, block diagrams, etc. These data were obtained from the reference material listed in item 11.

b. What Types of Payloads

The types of payloads that could use this item are listed. The types of payloads are: automated, automated with IUS (interim upper stage), automated with SSUS (solid spinning upper stage), and Spacelab payloads. In some cases the payload types were stated in the reference material (item 11), in others judgment was used to identify the type(s).

c. What STS Elements are Involved

This item identifies where in the STS the equipment is used (orbiter, IUS, Spacelab). The STS elements were selected from the description and application of the equipment item.

d. Describe Interface Requirements

Required services such as power and/or cooling from the orbiter, cabling, adaptors, etc. are identified. This material was identified from references listed in item 11 when available.

5. Identification of First Potential User and Year of First Use

The first potential user and the year in which the multiple mission equipment is expected to be used for the first time are both extracted from the reports referenced in the Ancillary Equipment User Reference Book (see item 11), or from discussions with NASA and DoD contacts.

6. Identify All Potential Users

Potential users are designated by nomenclature used in the NASA MSFC 1975 Space Shuttle Payload Description (References 19 and 20). Sometimes only classes of payloads such as Spacelab or automated payloads can be established as users of the equipment. The potential users designated are taken from the 1973 NASA Mission Model by Martin-Marietta (see Reference 6) and the list of DoD payloads studied by McDonnell Douglas (see References 11, 12, and 13) and by Rockwell International (see References 14 through 18).

7. Estimate Flight Rate or Number Required

The estimated number of uses is based on a modified NASA/MSFC 572-STS flight traffic model (see Reference 7). The number of multimission equipment units required is based on a study of payload requirements from the traffic model (Reference 7), modified as a result of discussions with study contacts.

8. Equipment Cost Estimate

An estimate of equipment cost is given when the data are available. The cost estimates assumed that new ancillary equipment will be developed and purchased. Cost estimates were provided in the reference material (see item 11). No cost estimates were available for ground equipment.

An estimated development schedule is also included. Development schedule estimates were obtained from one of the references in item 11.

9. Potential Value of Equipment

Savings of this multi-use equipment over payload-unique designs are included here when available. In other cases the alternative to this multi-use equipment is identified.

10. Status

Some of the questions answered in this item are: (1) has this equipment been funded, (2) is it planned for development, and (3) has it just been studied and proposed. The status of the ground equipment was obtained from Reference 2 and discussions with Charles Hart (NASA/KSC). The status of spaceborne equipment was obtained from Reference 9 and discussions with Jack Heberlig (NASA/JSC) and other contacts.

11. Reference(s) for Additional Data

The data provided in this form are necessarily brief. These references are provided for an interested potential user to obtain more details and requirements regarding a specific piece of equipment.

12. Contact

This is the name of the person to contact for information regarding the item of ancillary equipment.

Data were not available for all items in each ancillary equipment description. In these cases the lack of data is shown by "TBD," symbolizing that the information is to be determined.

3. ANCILLARY EQUIPMENT DATA FORMS

A list of the ancillary equipment data forms contained in this section is shown in Table 3-1. The formatted data and information are for both spaceborne and ground ancillary equipment.

Table 3-1. List of Ancillary Equipment Data Forms In
User Reference Book

GROUND EQUIPMENT

1. Launch Site Transportation System
 - a. Payload Canister - KMA-MH-10 (A70-0861)
 - b. Transporter, Payload Canister - KMA-MH-39 (P70-0559)
 - c. Payload Handling Fixture (Strong Back) - KMA-MH-19 (H70-0802)
 - d. Environmental Conditioning Unit (ECU) - KMA-MH-44 (H70-0831)
 - e. Instrumentation and Communication Unit (I&C) - KMA-MH-26 (H70-0832)
 - f. Payload Canister Access Equipment - KMA-MH-03 (A70-0864)
2. Launch Site Service Carts
 - a. Set, Hydrazine Service - KMB-MS-01
 - b. Set, Instrument Gas Service - KMB-MS-02
 - c. Set, Liquid Helium Service - KMB-MS-0
 - d. Cart, Payload Purge - KMB-MS-09
 - e. Set, Liquid Hydrogen Service - KMB-SS-02
 - f. Set, Liquid Nitrogen Service - KMB-SS-03
 - g. Set, Liquid Oxygen Service - KMB-SS-05

Table 3-1. List of Ancillary Equipment Data Forms In
User Reference Book (Cont'd)

GROUND EQUIPMENT (CONT'D)

3. Multipurpose Work Stands, Access Platforms, and Slings
 - a. Access Platform, Spacecraft Assembly Stand, Vertical - KMB-MH-06
 - b. Sling Set, Multipurpose - KMB-MH-27
 - c. Stand, Spacecraft Assembly, Vertical - KMB-MH-34
 - d. Stand, Work, Payload Assembly/Test, Horizontal - KMB-AH-30
4. Cargo Integration Test Equipment
5. Outsized Payload Transportation System

SPACEBORNE EQUIPMENT

1. Pointing and Stabilization Systems
 - a. Small Instrument Pointing System (SIPS)
 - b. Annular Suspension and Pointing System (ASPS)
 - c. Instrument Pointing System
2. Electrical Cabling
 - a. Automated Payload/IUS Cabling - 330-03-09-02
 - b. Automated Payload/Orbiter Cabling - 330-03-09-01
3. Contamination Monitoring
 - a. Induced Environment Contamination Monitor (IECM)
 - b. Trace Gas Analyzer

Table 3-1. List of Ancillary Equipment Data Forms In
User Reference Book (Cont'd)

SPACEBORNE EQUIPMENT (CONT'D)

4. Manned Maneuvering Unit
5. Auxiliary Power Systems
 - a. Auxiliary Payload Power System (APPS)
 - b. Multi-Discipline Auxiliary Payload Power System (MAPPS)
6. Payload Specialist Station
7. RTG Cooling Unit
8. Second Ku-Band Antenna
9. Cradle/Non-IUS Payload
10. Multi-Use Fluid Lines Kit
11. Umbilical Connector
12. Avionics Equipment
 - a. Multiplexer/Demultiplexer
 - b. Electrical Isolation, Conditioning, and Distribution Assembly
 - c. Dedicated Recorder
 - d. PCM Unit
 - e. DC-DC Converter/Regulator

GROUND EQUIPMENT (see Note 1, page 3-5a)

1. Launch Site Transportation System
 - a. Payload Canister - KMA-MH-10 (A70-0861)
 - b. Transporter, Payload Canister - KMA-MH-39 (P70-0559)
 - c. Payload Handling Fixture (Strong Back) - KMA-MH-19 (H70-0802)
 - d. Environmental Conditioning Unit (ECU) - KMA-MH-44 (H70-0831)
 - e. Instrumentation and Communication Unit (I&C) - KMA-MH-26 (H70-0832)
 - f. Payload Canister Access Equipment - KMA-MH-03 (A70-0864)

2. Launch Site Service Carts (see Note 2, page 3-5a)
 - a. Set, Hydrazine Service - KMB-MS-01
 - b. Set, Instrument Gas Service - KMB-MS-02
 - c. Set, Liquid Helium Service - KMB-MS-03
 - d. Cart, Payload Purge - KMB-MS-09
 - e. Set, Liquid Hydrogen Service - KMB-SS-02
 - f. Set, Liquid Nitrogen Service - KMB-SS-03
 - g. Set, Liquid Oxygen Service - KMB-SS-05

3. Multipurpose Work Stands, Access Platforms and Slings (see Note 2, page 3-5a)
 - a. Access Platform, Spacecraft Assembly Stand, Vertical (KMB-MH-06)
 - b. Sling Set, Multipurpose (KMB-MH-27)
 - c. Stand, Spacecraft Assembly, Vertical (KMB-MH-34)
 - d. Stand, Work, Payload Assembly/Test, Horizontal (KMB-AH-30)

4. Cargo Integration Test Equipment (see Note 3, page 3-5a)

5. Outsized Payload Transportation System

NOTES:

1. Category "A"

The transportation equipment used at the launch site to move payloads from the O&C Bldg. or SAEF #1 to the OPF or the launch pad. FY77 funds have been provided to KSC for development of these hardware items.
2. Payload Servicing Equipment (PSE)

The Payload Servicing Equipment used at the launch site to service payloads and that which is maintained in an inventory for multi-program usage. Many of the items currently identified in the draft baseline requirements document could be supplied by the payload development centers. These PSE items are unfunded and not yet baselined.
3. Cargo Integration Test Equipment (CITE)

The horizontal and vertical workstands used to check out a total Shuttle cargo and demonstrate compatibility with the orbiter off-line. FY77 funds have been provided to KSC for development of this hardware.
4. Intersite Transportation Equipment (T-MMSE)

The Intersite Transportation Equipment used to move payloads over the road to the launch site from the development or integration location. (This equipment is not included in this present volume.)

1. NAME AND IDENTIFYING NUMBER:

Launch Site Transportation System (see Note 1, page 3-5a)

2. EQUIPMENT DESCRIPTION: (See Figure)

Includes:

- Payload Canister - KMA-MH-10 (A70-0861)
- Transporter, Payload Canister - KMA-MH-39 (P70-0559)
- Payload Handling Fixture (Strong Back) - KMA-MH-19 (H70-0802)
- Environmental Conditioning Unit (ECU) - KMA-MH-44 (H70-0831)
- Instrumentation and Communication Unit (I&C) - KMA-MH-26 (H70-0832)
- Payload Canister Access Equipment - KMA-MH-03 (A70-0864)

3. PHYSICAL CHARACTERISTICS:

- (a) Size } See Individual Items
(b) Weight }

4. PURPOSE AND INTENDED APPLICATION:

(a) Function and Capability:

Provides capability for handling and transporting payloads or experiments during launch (recovery) site ground operations. The system also includes a protective shroud, conditioned air, and monitor and record equipment for payload environment data.

(b) What Types of Payloads:

Automated, automated with IUS, SSUS and mixed cargoes, Spacelab

(c) What STS Elements are Involved:

IUS, Spacelab

(d) Describe Interface Requirements:

See Individual Items

5. IDENTIFY FIRST POTENTIAL USER AND YEAR OF FIRST USE:

OFT #3, March 1979

Launch Site Transportation System (Cont'd)

6. IDENTIFY ALL POTENTIAL USERS:

All NASA, DoD and Civil Payloads

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

See Individual Items

8. EQUIPMENT COST ESTIMATE:

Non-Recurring

Recurring

Development Schedule

} (See Individual Items)

9. POTENTIAL VALUE OF EQUIPMENT:

Avoid each payload program providing and maintaining these equipment items.

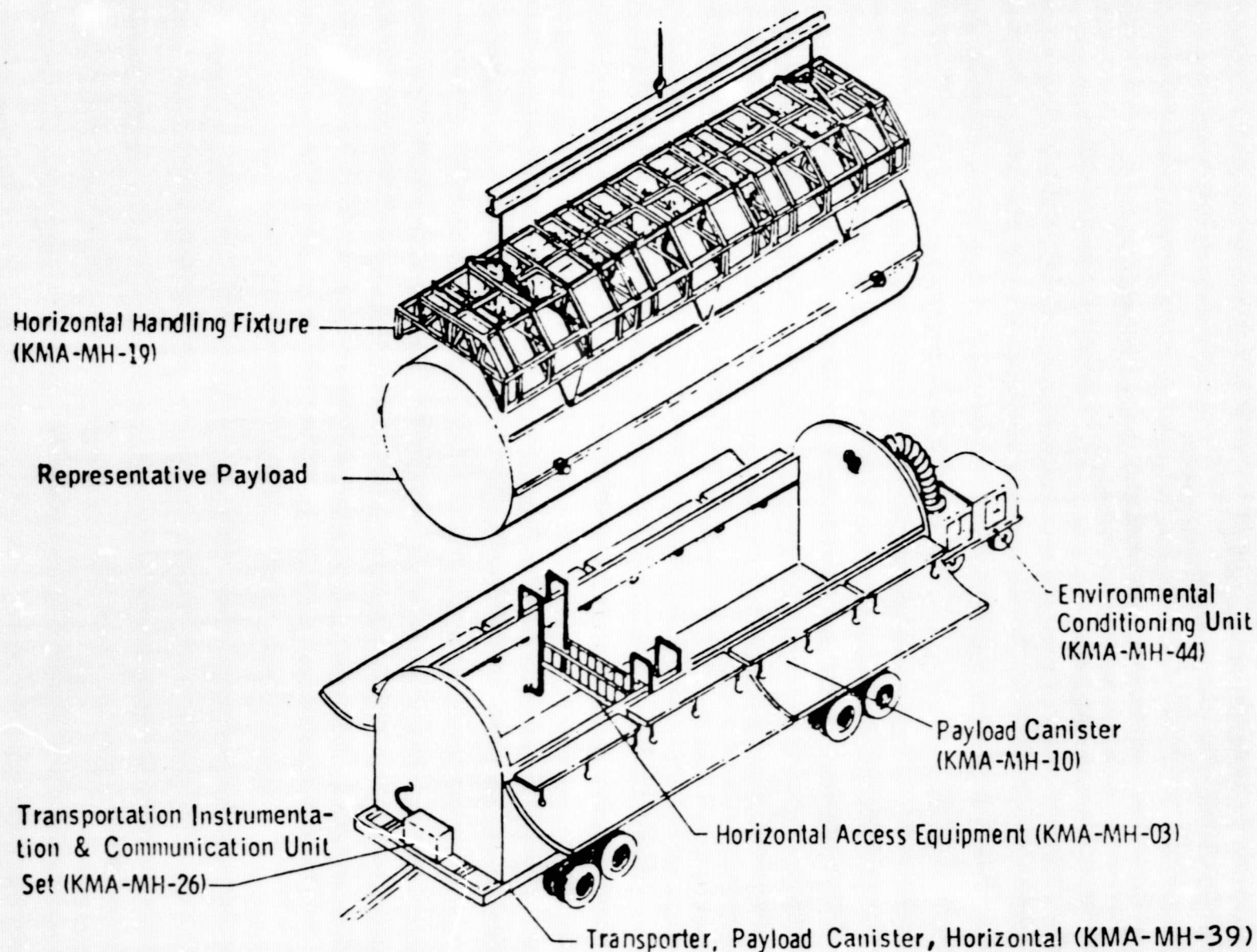
10. STATUS:

FY77 funds have been provided to KSC for hardware development.

11. REFERENCE(S) FOR ADDITIONAL DATA:

See Individual Items

12. CONTACT: C. Hart - NASA/KSC



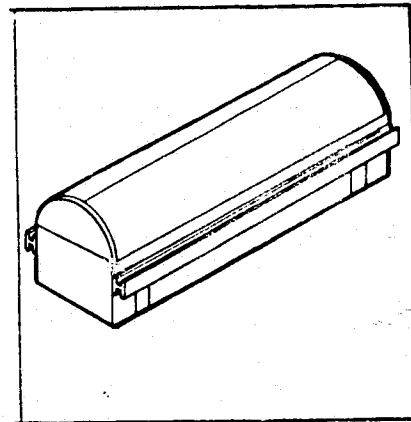
Launch Site Transportation System

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Payload Canister KMA-MH-10 (A70-0861)

2. EQUIPMENT DESCRIPTION:

This canister will be sized equal to the orbiter payload bay. Pickup points/retention fittings will be similar in type, quantity, and location to the orbiter. Access doors will be along the top of the canister and operate identical to the orbiter doors relative to allowable envelopes and clearances. Viewports will be provided and provisions for personnel access to the interior from ground level. Included are service panels, tie downs, and lift points to allow rotation of the loaded/unloaded canister. Its closure device and external sizing will be compatible with the PCR. WTR units do not require sizing to be compatible with the PCR. A sling set shall be provided for lift and rotation of the payload canister.



3. PHYSICAL CHARACTERISTICS:

- a. Size: Interior 15 ft. diameter, 60 ft. long
- b. Weight:

4. PURPOSE AND INTENDED APPLICATION:

a. Function and Capability:

This container will provide a protective shroud for all configurations of payloads during transfer from the various payload processing facilities to the orbiter (OPF or pad) and return. Provides mating with PCR and environmental maintenance during loading and unloading at the PCR.

b. What Types of Payloads:

Automated, automated with IUS, Spacelab, SSUS and mixed cargoes

c. What STS Elements are Involved:

IUS, Spacelab

Payload Canister KMA-MH-10 (A70-0861) - Cont'd

d. Describe Interface Requirements:

- (1) Payload Canister Transporter
- (2) Horizontal Access Equipment
- (3) PCR
- (4) Ground Power, Environmental Conditioning, Environmental Monitoring, and RTG Cooling Systems

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

OFT #3, 1 March 1979

6. IDENTIFY ALL POTENTIAL USERS:

All NASA, DoD and Civil Payloads

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

1979-1981 2 Required

1982-1991 As Required

8. EQUIPMENT COST ESTIMATE:

Non-recurring - TBD

Recurring - TBD

Development Schedule: Started January 1976; Delivery January 1978

9. POTENTIAL VALUE OF EQUIPMENT:

Each payload program could provide container

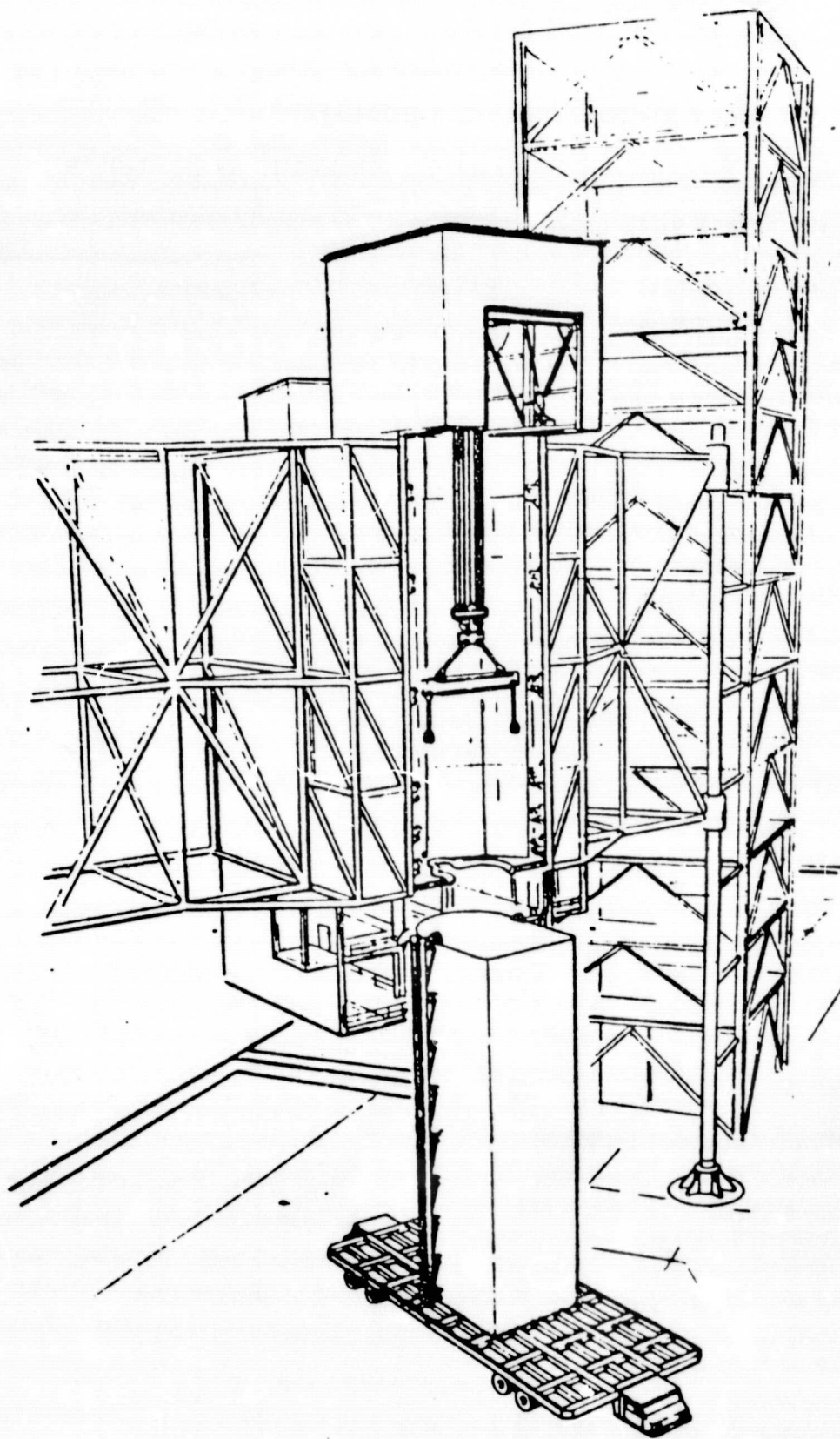
10. STATUS:

FY77 funds have been provided to KSC for hardware development.

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. Revision D, MMSE Catalog for MMSE at Launch Site, February 1976
- b. STS Users Study (Study 2.2) Final Report, Volume III: Ancillary Equipment Study, ATR-76(7362)-1
- c. K-SM-03.2, KSC, Schedules and Status Summary, Volume 2, Payload Integration, October 1976
- d. SAMSO-TR-76-103, DoD Space Transportation System Payload Interface Support Study, Book 2, Final Report, MDAC, December 1976

12. CONTACT: C. Hart - NASA/KSC



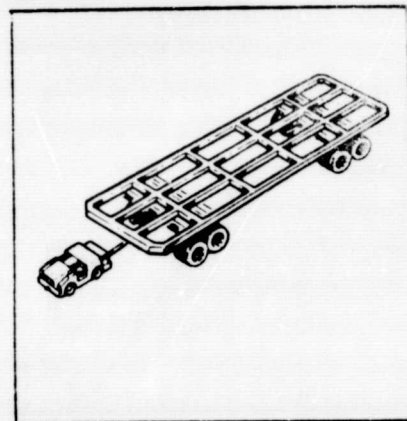
PAYLOAD CANISTER

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Transporter, Payload Canister KMA-MH-39 (P70-0559)

2. EQUIPMENT DESCRIPTION:

The transporter will support the loaded or unloaded payload canister horizontally or vertically. The unit will have a flat bed (approximately 18 feet wide by 65 feet long) with tie-down provisions included. It will be towable from either end by a prime mover, have steerable front and rear wheels, have self-contained braking and stabilization jacking provisions, and a suspension system to minimize over the road shock and vibration. It will have provisions for the accompanying transport of support equipment required by the payload during transport such as environmental conditioning and monitoring equipment.



3. PHYSICAL CHARACTERISTICS:

- a. Size: 18 x 65 feet
- b. Weight:

4. PURPOSE AND INTENDED APPLICATION:

a. Function and Capability

This unit will provide a capability to transport the payload canister (KMA-MH-10) between selected payload processing facilities, the orbiter processing facility (OPF), and VAB and the launch pad.

b. What Types of Payloads:

Automated, automated with IUS, Spacelab, SSUS and mixed cargoes

c. What STS Elements are Involved:

IUS, Spacelab

d. Describe Interface Requirements:

- (1) Payload Canister
- (2) Transportation Instrumentation and Communication Unit Set
- (3) Environmental Conditioning Unit

Transporter, Payload Canister KMA-MH-39 (P70-0559) - Cont'd

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

OFT #3, March 1979

6. IDENTIFY ALL POTENTIAL USERS:

All NASA, DoD and Civil Payloads

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

1979-1981 2 Required

1982-1991 As Required

8. EQUIPMENT COST ESTIMATE:

Non-Recurring - TBD

Recurring - TBD

Development Schedule - Design CY 1976; Delivery January 1978

9. POTENTIAL VALUE OF EQUIPMENT:

Use existing transporters where possible

10. STATUS:

FY77 funds have been provided to KSC for hardware development.

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. Revision D, MMSE Catalog for MMSE at Launch Site, February 1976
- b. STS Users Study (Study 2.2) Final Report, Volume III: Ancillary Equipment Study, ATR-76(7362)-1
- c. K-SM-03.2, KSC, Schedules and Status Summary, Volume 2, Payload Integration, October 1976

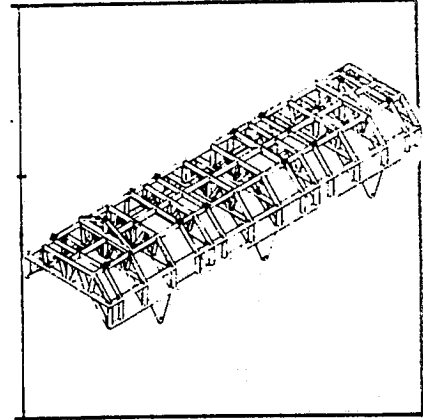
12. CONTACT: C. Hart - NASA/KSC

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Payload Handling Fixture (Strong Back) KMA-MH-19 (H70-0802)

2. EQUIPMENT DESCRIPTION:

The fixture (strong back) will be a rigid frame device consisting of beams, cables, attach hook devices, and rings adjustable to accommodate varying lengths and shifting c.g.'s of payloads up to 15' diameter, 60' length, and 65,000 pounds weight. It will interface with the payload on a non-interference basis such that engagement and load transference to attachment/retention points can occur while the handling fixture is still attached. It will support an IUS/Tug with payload by attachment to the carrier only, and automated by attachment to the spacecraft or to a spacecraft-orbiter adapter. It will not induce any bending or twisting loads on any payload element. The fixture shall have incorporated into its design a sling set which will interface with the cranes and will lift the payload.



3. PHYSICAL CHARACTERISTICS:

- a. Size: 7 x 15 x 60 feet
- b. Weight:

4. PURPOSE AND INTENDED APPLICATION:

- a. Function and Capability:

Provide a capability for lifting all payload configurations in a horizontal orientation and positioning them for installation into or removal from the payload canister, orbiter payload bay, and the test and checkout stands.

- b. What types of Payloads:

Automated, automated with IUS, Spacelab, SSUS and mixed cargoes

- c. What STS Elements are Involved:

IUS, Spacelab

- d. Describe Interface Requirements:

TBD

Payload Handling Fixture (Strong Back) KMA-MH-19 (H70-0802) - Cont'd

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

OFT #3, March 1979

6. IDENTIFY ALL POTENTIAL USERS:

All Spacelab, automated and automated with IUS loaded horizontally (includes two DoD payloads)

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

1979-1981 2 Required

1982-1991 As Required

8. EQUIPMENT COST ESTIMATE:

Non-Recurring - TBD

Recurring - TBD

Development Schedule - Design start April 1976; Delivery 1 July 1978

9. POTENTIAL VALUE OF EQUIPMENT:

Each payload provides special handling equipment. Transition payloads can use existing provisions.

10. STATUS:

FY77 funds have been provided to KSC for hardware development.

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. Revision D, MMSE Catalog for MMSE at Launch Site, February 1976
- b. STS Users Study (Study 2.2) Final Report, Volume III: Ancillary Equipment Study, ATR-76(7362)-1
- c. K-SM-03.2, KSC, Schedules and Status Summary, Volume 2, Payload Integration, October 1976

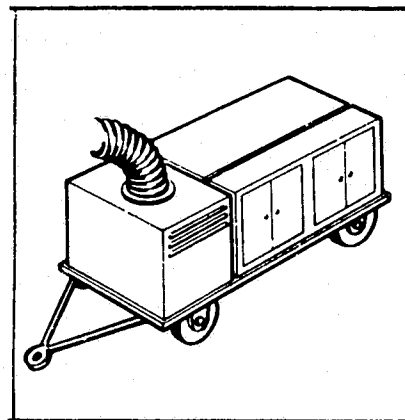
12. CONTACT: C. Hart - NASA/KSC

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Environmental Conditioning Unit (ECU) KMA-MH-44 (H70-0831)

2. EQUIPMENT DESCRIPTION:

This unit will be towable from either end and contain the electrical generating system to power its air conditioning system. The air conditioning system will provide an air purge to the payload canister.



3. PHYSICAL CHARACTERISTICS:

a. Size:

b. Weight:

4. PURPOSE AND INTENDED APPLICATION:

a. Function and Capability

To provide conditioned air to maintain payloads within environmental limits when in the payload canister. Unit will provide a flow rate of 112-265 lb/min, temperature selectable within a range of 65° - 85°F, cleanlines nominally class 100, guaranteed class 5,000 (HEPA filtered) air with 15 PPM or less hydro carbons, and humidity equal to 0-34 grains water/lb or dry air (35°F dew point).

b. What Types of Payloads:

Automated, Automated with IUS, Spacelab, SSUS and mixed cargoes

c. What STS Elements Involved:

IUS, Spacelab

d. Describe Interface Requirements:

- (1) Payload Canister
- (2) Payload Canister Transporter

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

OFT #3, March 1979

Environmental Conditioning Unit (ECU) KMA-MH-44 (H70-0831) - Cont'd

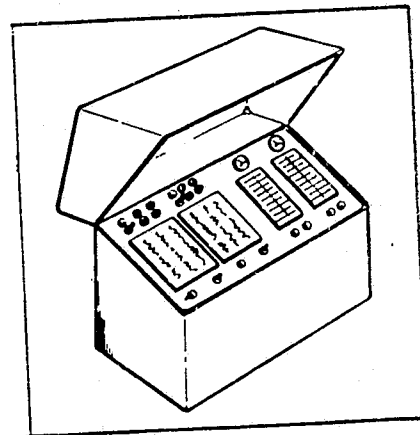
6. IDENTIFY ALL POTENTIAL USERS:
All NASA, DoD and Civil Payloads
7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:
1979-1981 3 Required
1982-1991 As Required
8. EQUIPMENT COST ESTIMATE:
Non-Recurring - TBD
Recurring - TBD
Development Schedule - Design October 1976, Delivery January 1979
9. POTENTIAL VALUE OF THE EQUIPMENT:
Avoids each payload providing separate conditioning units.
10. STATUS
FY77 funds have been provided to KSC for hardware development.
11. REFERENCE(S) FOR ADDITIONAL DATA:
 - a. Revision D, MMSE Catalog for MMSE at Launch Site, February 1976
 - b. K-SM-03.2, KSC, Schedules and Status Summary, Volume 2, Payload Integration, October 1976
 - c. STS Users Study (Study 2.2) Final Report, Volume III: Ancillary Equipment Study, ATR-76(7362)-1
12. CONTACT: C. Hart - NASA/KSC

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Instrumentation and Communication Unit KMA-MH-26 (H70-0832)

2. EQUIPMENT DESCRIPTION:

The transportation instrumentation set will monitor and record acceleration, temperature, and humidity as experienced by the payload while installed in a canister during transit. The set will be self-contained, consisting of a power supply, transducers, signal conditioning equipment, and interface cabling.



3. PHYSICAL CHARACTERISTICS:

a. Size:

b. Weight:

4. PURPOSE AND INTENDED APPLICATION:

a. Function and Capability:

Provide a capability to monitor and record payload environment data when in the payload canister. Environmental characteristics to be monitored shall include shock, vibration, temperature, humidity, cleanliness, and pressure. External temperature and relative humidity shall also be measured and recorded. Accommodations are required for detection of hazardous conditions, as well as for payload-peculiar monitoring requirements. A ground observer communication capability will be provided.

b. What Types of Payloads:

Automated, Automated with IUS, Spacelab, SSUS and Mixed Cargoes

c. What STS Elements are Involved:

IUS, Spacelab

d. Describe Interface Requirements:

- (1) Payload Canister
- (2) Payload Canister Transporter

Instrumentation and Communication Unit KMA-MH-26 (H70-0832) - Cont'd

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

OFT #3, March 1979

6. IDENTIFY ALL POTENTIAL USERS:

All NASA, DoD and Civil Payloads

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

1979-1981 2 Required

1982-1991 As Required

8. EQUIPMENT COST ESTIMATE:

Non-Recurring - TBD

Recurring - TBD

Development Schedule - Start design October 1976; Deliver January 1979

9. POTENTIAL VALUE OF EQUIPMENT:

Avoids each payload providing monitoring set.

10. STATUS:

FY77 funds have been provided to KSC for hardware development.

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. Revision D, MMSE Catalog of MMSE (Launch Site), February 1976
- b. K-SM-03.2, KSC, Schedules and Status Summary, Volume 2, Payload Integration, October 1976

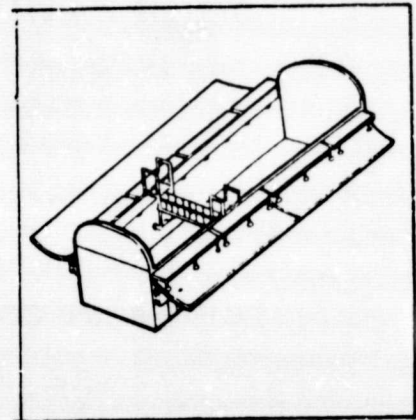
12. CONTACT: C. Hart - NASA/KSC

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Payload Canister Access Equipment - Horizontal KMA-MH-03 (A70-0864)

2. EQUIPMENT DESCRIPTION:

This equipment consists of a bridge type structure to span the payload (or payload element) canister and walkway platforms along each side of the canister. The bridge will include the capability of being lowered or raised and, at its maximum elevation, will have sufficient height to clear all payloads. The walkway runs the entire length of each side of the canister and is mounted to the edge of the canister and supported by the open canister door. The walkway is sectioned for localized use and portability. Access to the canister walkway and to the exterior canister surface will be provided by general purpose access equipment.



3. PHYSICAL CHARACTERISTICS:

a. Size:

b. Weight:

4. PURPOSE AND INTENDED APPLICATION:

a. Function and Capability:

Provide the capability to access the payload canister and payload-handling fixture interface locations during payload installation into, or removal from, the canister when in a horizontal position.

Operations to be supported by the equipment include:

- (1) Maintenance, reconfiguration, and servicing of the canister
- (2) Payload installation and interface connection
- (3) Interface disconnection and payload removal.

b. What Types of Payloads:

Automated, Automated with IUS, Spacelab, SSUS and Mixed Cargoes

Payload Canister Access Equipment - Horizontal KMA-MH-03 (A70-0864) Cont'd.

c. What STS Elements are Involved:

IUS, Spacelab

d. Describe Interface Requirements:

(1) Payload Canister

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

OFT #3, March 1979

6. IDENTIFY ALL POTENTIAL USERS:

All NASA, DoD and Civil Payloads

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

1979-1981 2 Required

1982-1991 As Required

8. EQUIPMENT COST ESTIMATE:

Non-Recurring - TBD

Recurring - TBD

Development Schedule - Start design January 1977; Deliver January 1979

9. POTENTIAL VALUE OF EQUIPMENT:

Require other payload access equipment.

10. STATUS:

FY77 funds have been provided to KSC for hardware development.

11. REFERENCE(S) FOR ADDITIONAL DATA:

a. Revision D, MMSE Catalog of MMSE (Launch Site), February 1976

b. K-SM-03.2, KSC, Schedules and Status Summary, Volume 2, Payload Integration, October 1976

12. CONTACT: C. Hart - NASA/KSC

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Launch Site Service Carts (see Note 2, page 3-5a)

2. EQUIPMENT DESCRIPTION: (See concept sketch on individual item)

Includes:

- Set, Hydrazine Service - KMB-MS-01
- Set, Instrument Gas Service - KMB-MS-02
- Set, Liquid Helium Service - KMB-MS-03
- Cart, Payload Purge - KMB-MS-09
- Set, Liquid Hydrogen Service - KMB-SS-02
- Set, Liquid Nitrogen Service - KMB-SS-03
- Set, Liquid Oxygen Service - KMB-SS-05

3. PHYSICAL CHARACTERISTICS:

- a. Size: {
b. Weight: { See Individual Items

4. PURPOSE AND INTENDED APPLICATION:

- a. Capability and Function:

Provide gas and cryogenics service, as required, to payloads at the pad and payload processing facilities.

- b. What Types of Payloads:

Spacelab, Automated, Automated with IUS

- c. What STS Elements are Involved:

None

- d. Describe Interface Requirements:

See Individual Items

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

See Individual Items

6. IDENTIFY ALL POTENTIAL USERS:

See Individual Items

Launch Site Service Carts - Cont'd

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

See Individual Items

8. EQUIPMENT COST ESTIMATE:

Non-Recurring

Recurring

Development Schedule

} See Individual Items

9. POTENTIAL VALUE OF EQUIPMENT:

Avoid each payload program providing and maintaining the required equipment at the launch site.

10. STATUS:

A review of existing equipment to satisfy requirements is in process

11. REFERENCE(S) FOR ADDITIONAL DATA:

See Individual Items

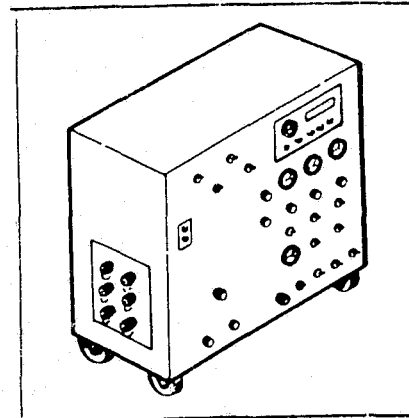
12. CONTACT: C. Hart - NASA/KSC

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Set, Hydrazine Service - KMB-MS-01

2. EQUIPMENT DESCRIPTION:

The set is a self-contained unit that will contain fluid storage and refill capability, all plumbing and fittings, service hoses, gaging, pumps, regulators, valves, filters and metering to accomplish fill, drain, flush and purge of payload hydrazine systems. Three separate systems are included so that MMH, N_2H_4 , and N_2O_4 can be handled independently. The set is movable and includes provisions to utilize facility power and GN_2 .



3. PHYSICAL CHARACTERISTICS:

a. Size: TBD

b. Weight: TBD

4. PURPOSE AND INTENDED APPLICATION:

a. Function and Capability:

This equipment is used to fill, drain, flush and purge, as required, the hydrazine systems of the orbiter, Spacelab, and IUS payloads.

b. What Types of Payloads:

Automated, Automated with IUS, Spacelab

c. What STS Elements are Involved:

None

d. Describe Interface Requirements:

Facility power and GN_2 - requires standardization of payload connections.

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

EO-08-A, March 1980

Set, Hydrazine Service - KMB-MS-01 (Cont'd)

6. IDENTIFY ALL POTENTIAL USERS:

NASA; HE-01, 08, 09, 11-A; PL-07, 09, 12, 14, 19, 20, 21, 22, 28, 29, 32, 33-A; EO-08, 10, 12, 57, 58, 61-A; AP-01, 02, 05, 07-A; CN-51, 52, 53, 55, 56, 58-A; LS-04-S

DoD: DSCS-III, FSC, DSP, STP, GPS, DMSP, plus 5 Others

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

1979-1981 1 Required

1982-1991 As Required

8. EQUIPMENT COST ESTIMATE:

Non-Recurring - TBD

Recurring - TBD

Development Schedule - Start design October 1977; Deliver March 1980

9. POTENTIAL VALUE OF EQUIPMENT:

Each program would provide a unit

10. STATUS:

A review of existing equipment to satisfy requirement is in process

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. Revision D, MMSE Catalog, MMSE (Launch Site) MMC, February 1976
- b. ATR-76(7362)-1, Vol. III, Ancillary Equipment Study, STS Users Study (Study 2.2) Final Report, Aerospace, November 1975
- c. K-SM-03.2, KSC, Schedules and Status Summary, Volume 2, Payload Integration, October 1976
- d. Payload Descriptions, Volumes I, II, Level B Data for Automated and Sortie Payloads, July 1975 (SSPD)

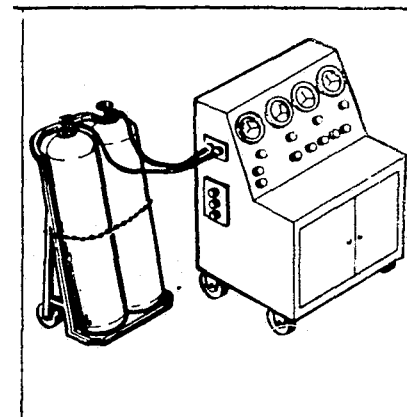
12. CONTACT: C. Hart - NASA/KSC

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Set, Instrument Gas, Service - KMB-MS-02

2. EQUIPMENT DESCRIPTION:

The set is a self-contained unit that will house all the necessary tanks, valves, regulators, filters, flex lines, and fittings to accomplish instrument gas transfer to required payloads. Tanks will be sized to allow full servicing with at least 50% reserve. The system is equipped with variable flow and pressure capability, automatic and manual safety relief valves, a system status display panel, a gas filtering system, and tank refill capability. The set is portable.



3. PHYSICAL CHARACTERISTICS:

- a. Size: TBD
- b. Weight: TBD

4. PURPOSE AND INTENDED APPLICATIONS:

a. Capability and Function:

This equipment is used to supply instrument gas, as required, to orbiter, IUS, and Spacelab payloads at the pad and at the processing facilities.

b. What Types of Payloads:

Automated, Automated with IUS, Spacelab

c. What STS Elements are Involved:

None

d. Describe Interface Requirements:

Requires standardization of payload connections

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

HE-17-S, May 1979

Set, Instrument Gas, Service - KMB-MS-02 (Cont'd)

6. IDENTIFY ALL POTENTIAL USERS:

NASA: HE-07-A, HE-08-A, HE-09-A, HE-11-3, HE-12-S,
HE-13-S, HE-14-S, HE-15-S, HE-17-S, HE-18-S,
HE-22-S, HE-25-S, HE-26-S, HE-27-S

DoD: TBD

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

1979-1981 1 Required
1982-1991 As Required

8. EQUIPMENT COST ESTIMATE:

Non-Recurring - TBD

Recurring - TBD

Development Schedule - Start design January 1977; Deliver May 1979

9. POTENTIAL VALUE OF EQUIPMENT:

Each program would provide a unit

10. STATUS:

A review of existing equipment to satisfy requirement is in process

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. Revision D, MMSE Catalog, MMSE (Launch Site), MMC, February 1976
- b. ATR-76(7362)-1, Volume III: Ancillary Equipment Study, STS Users Study (Study 2.2) Final Report, Aerospace, November 1975
- c. K-SM-03.2, KSC, Schedules and Status Summary, Volume 2, Payload Integration, October 1976
- d. Payload Descriptions, Volumes I and II, Level B Data for Automated and Sortie Payloads, July 1975 (SSPD)

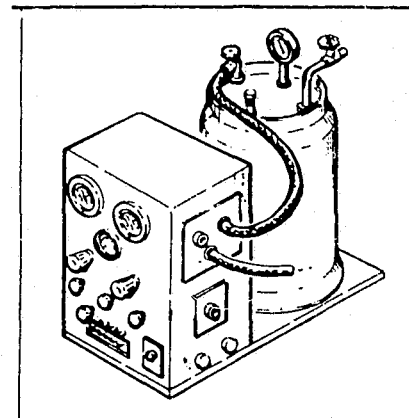
12. CONTACT: C. Hart - NASA/KSC

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Set, Liquid Helium, Service - KMB-MS-03

2. EQUIPMENT DESCRIPTION:

The Liquid Helium Service Set is a self-contained unit that will consist of a liquid helium dewar, insulated transfer lines, valves and payload fittings, instrumentation, and gaseous helium transfer pressurization and purge accommodations. This unit is portable and includes provisions to utilize facility power.



3. PHYSICAL CHARACTERISTICS:

a. Size: TBD

b. Weight: TBD

4. PURPOSE AND INTENDED APPLICATION:

a. Capability and Function:

This equipment is used to supply liquid helium, as required, to the orbiter, IUS, and Spacelab payloads at the pad and payload processing facilities.

b. What Types of Payloads:

Automated, Automated with IUS, Spacelab

c. What STS Elements are Involved:

None

d. Describe Interface Requirements:

Requires standardization of connections

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

AP-04-A, September 1980

Set, Liquid Helium, Service - KMB-MS-03 (Cont'd)

6. IDENTIFY ALL POTENTIAL USERS:

NASA: AS-01-S, AS-03-S, AS-14-S, AS-15-S, AS-18-S,
AS-20-S, AS-31-S, AS-32-S, AS-51-S, AS-54-S,
AS-61-S; HE-15-S, HE-01-A, HE-09-A, HE-11-A,
HE-12-A; SO-02-A, SO-06-A; AP-04-A, AP-06-A;
ST-59-S; HE-21-S; HE-22-S; SO-13-S; AP-06-S

DoD: TBD

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED

1979-1981 1 Required
1982-1991 As Required

8. EQUIPMENT COST ESTIMATE:

Non-Recurring - TBD

Recurring - TBD

Development Schedule - Start Design November 1978;
Deliver September 1980

9. POTENTIAL VALUE OF EQUIPMENT:

Each program would provide a unit

10. STATUS:

A review of existing equipment to satisfy requirement is in
process

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. Revision D, MMSE Catalog, MMSE (Launch Site), MMC, February 1976
- b. ATR-76(7362)-1, Volume III: Ancillary Equipment Study, STS
Users Study (Study 2.2) Final Report, Aerospace, November 1975
- c. K-SM-03.2, KSC, Schedules and Status Summary, Volume 2,
Payload Integration, October 1976
- d. Payload Descriptions, Volumes I and II, Level B Data for Automated
and Sortie Payloads, July 1975 (SSPD)

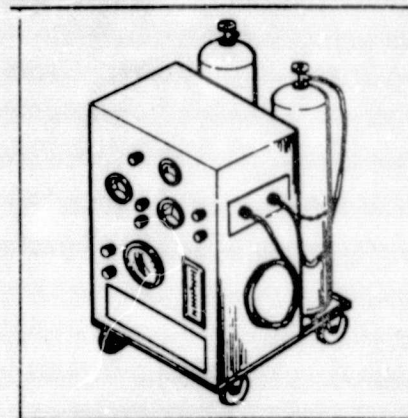
12. CONTACT: C. Hart - NASA/KSC

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Cart, Payload Purge - KMB-MS-09

2. EQUIPMENT DESCRIPTION:

The Purge Cart will be a mobile self-contained unit to supply small quantities of gaseous nitrogen or helium, as required, to purge a payload internally. The unit will contain gas supplies, gages, valves, regulators, hoses and fittings to interface with payloads or the payload canister.



3. PHYSICAL CHARACTERISTICS:

- a. Size:
- b. Weight:

4. PURPOSE AND INTENDED APPLICATION:

- a. Capability and Function:

This item of equipment is used to provide a positive pressure internal to the payload to maintain internal cleanliness.

- b. What Types of Payloads:

Automated, Automated with IUS, Spacelab

- c. What STS Elements are Involved:

None

- d. Describe Interface Requirements:

Requires standardization of connections

5. IDENTIFICATION IF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

AS-41-S, January 1980

6. IDENTIFY ALL POTENTIAL USERS:

NASA: AS-01, 02, 05; 23-A; HE-01, 03, 07, 08, 09, 11, 12-A; SO-03-A; AS-03, 04, 09, 19, 32, 41, 42, 48, 50, 54, 63, 66-S; HE-11, 19, 20, 23-S; SO-14, 16, 18, 19, 20, 21, 23-S; AP-01, 02, 03, 04, 05-A; OP-03-A

DoD: TBD

Cart, Payload Purge - KMB-MS-09 (Cont;d)

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

1979-1981 1 Required

1982-1991 As Required

8. EQUIPMENT COST ESTIMATE:

Non-Recurring - TBD

Recurring - TBD

Development Schedule - Start Design October 1977; Deliver
January 1980

9. POTENTIAL VALUE OF EQUIPMENT:

Each program would provide a unit

10. STATUS:

A review of existing equipment to satisfy requirement is in
process

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. Revision D, MMSE Catalog, MMSE (Launch Site), MMC, February 1976
- b. ATR-76(7362)-1, Volume III: Ancillary Equipment Study, STS
Users Study (Study 2.2) Final Report, Aerospace, November 1975
- c. K-SM-03.2, KSC, Schedules and Status Summary, Volume 2,
Payload Integration, October 1976
- d. Payload Descriptions, Volumes I and II, Level B Data for Automated
and Sortie Payloads, July 1975 (SSPD)

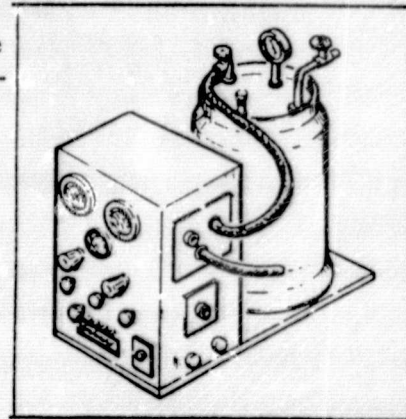
12. CONTACT: C. Hart - NASA/KSC

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Set, Liquid Hydrogen, Service - KMB-SS-02

2. EQUIPMENT DESCRIPTION:

The set is a self-contained unit that will house all the necessary tanks, valves, filters, regulators, lines and fittings to accomplish the required drain and fill functions. Tanks will be sized to allow full servicing of required payloads with at least 50% reserve. The system will be equipped with a variable flow and pressure capability, automatic and manual safety cutoff valves, a system status display system and a tank refill capability. The set is movable.



3. PHYSICAL CHARACTERISTICS:

a. Size:

b. Weight:

4. PURPOSE AND INTENDED APPLICATION:

a. Capability and Function:

This equipment is used to supply liquid hydrogen, as required, to orbiter payloads at the pad and Spacelab processing facilities.

b. What Types of Payloads:

Spacelab

c. What STS Elements are Involved:

None

d. Describe Interface Requirements:

Requires standardization of connections

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

SP-12-S, March 1980

Set, Liquid Hydrogen, Service - KMB-SS-02 (Cont'd)

6. IDENTIFY ALL POTENTIAL USERS:

NASA: AS-20-S, SP-01-S, SP-02-S, SP-03-S, SP-04-S,
SP-05-S, SP-12-S, SP-13-S, SP-14-S, SP-15-S,
SP-16-S, SP-19-S, SP-21-S, SP-31-S

DoD: TBD

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

1979-1981 1 Required

1982-1991 As Required

8. EQUIPMENT COST ESTIMATE:

Non-Recurring - TBD

Recurring - TBD

Development Schedule - Start November 1977; Deliver March 1980

9. POTENTIAL VALUE OF EQUIPMENT:

Each program would provide a unit

10. STATUS:

A review of existing equipment to satisfy requirement is in process

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. Revision D, MMSE Catalog, MMSE (Launch Site), MMC, February 1976
- b. ATR-76(7362)-1, Volume III: Ancillary Equipment Study, STS Users Study (Study 2.2) Final Report, Aerospace, November 1975
- c. K-SM-03.2, KSC, Schedules and Status Summary, Volume 2, Payload Integration, October 1976
- d. Payload Descriptions, Volumes I and II, Level B Data for Automated and Sortie Payloads, July 1975 (SSPD)

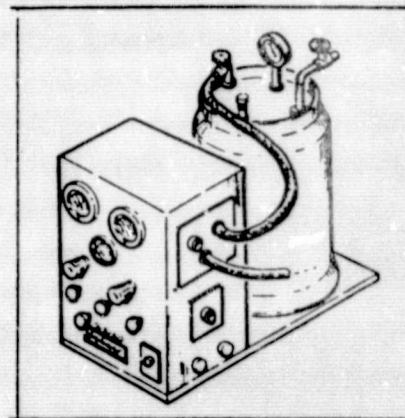
12. CONTACT: C. Hart - NASA/KSC

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Set, Liquid Nitrogen, Service - KMB-SS-03

2. EQUIPMENT DESCRIPTION:

The set is a self-contained unit that will house all the necessary tanks, valves, filters, regulators, lines and fittings to accomplish the required drain and fill functions. Tanks will be sized to allow full servicing of required payloads with at least 50% reserve. The system will be equipped with a variable flow and pressure capability, automatic and manual safety cutoff valves, a system status display system and a tank refill capability. The set is movable and includes provisions to utilize facility power.



3. PHYSICAL CHARACTERISTICS:

a. Size:

b. Weight:

4. PURPOSE AND INTENDED APPLICATION:

a. Capability and Function:

This equipment is used to supply liquid nitrogen, as required, to orbiter payloads at the pad and Spacelab processing facility.

b. What Types of Payloads:

Spacelab

c. What STS Elements are Involved:

None

d. Describe Interface Requirement:

Requires standardization of connections

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

EO-19-S, January 1980

Set, Liquid Nitrogen, Service - KMB-SS-03

6. IDENTIFY ALL POTENTIAL USERS:

NASA: LS-09-S, LS-10-S, SO-01-S, SO-11-S, AP-06-S,
EO-19-S

DoD: TBD

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

1979-1981 1 Required

1982-1991 As Required

8. EQUIPMENT COST ESTIMATE:

Non-Recurring - TBD

Recurring - TBD

Development Schedule - Start Design **October 1977**;
Deliver **January 1980**

9. POTENTIAL VALUE OF EQUIPMENT:

Each program would provide a unit

10. STATUS:

A review of existing equipment to satisfy requirement is in
process

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. Revision D, MMSE Catalog, MMSE (Launch Site), MMC, February 1976
- b. ATR-76(7362)-1, Volume III: Ancillary Equipment Study, STS
Users Study (Study 2.2) Final Report, Aerospace, November 1975
- c. K-SM-03.2, KSC, Schedules and Status Summary, Volume 2,
Payload Integration, October 1976
- d. Payload Descriptions, Volumes I and II, Level B Data for Automated
and Sortie Payloads, July 1975 (SSPD)

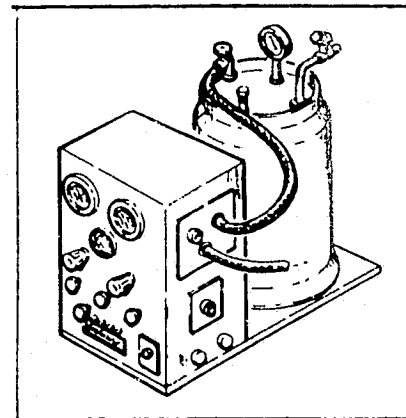
12. CONTACT: C. Hart - NASA/KSC

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Set, Liquid Oxygen, Service - KMB-SS-05

2. EQUIPMENT DESCRIPTION:

The set is a self-contained unit that will house all the necessary tanks, valves, filters, regulators, lines and fittings to accomplish the required drain and fill functions. Tanks will be sized to allow full servicing of required payloads with at least 50% reserve. The system will be equipped with a variable flow and pressure capability, automatic and manual safety cutoff valves, a system status display system and a tank refill capability.



3. PHYSICAL CHARACTERISTICS:

a. Size:

b. Weight:

4. PURPOSE AND INTENDED APPLICATION:

a. Capability and Function:

This equipment is used to supply liquid oxygen, as required, to orbiter payloads at the Spacelab processing facility.

b. What Types of Payloads:

Spacelab

c. What STS Elements are Involved:

None

d. Describe Interface Requirements:

Requires standardization of connections

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

AS-01-S, July 1, 1981

Set, Liquid Oxygen, Service - KMB-SS-05 (Cont'd)

6. IDENTIFY ALL POTENTIAL USERS:

NASA: SP-01-S, SP-02-S, SP-03-S, SP-04-S, SP-05-S,
SP-12-S, SP-13-S, SP-14-S, SP-15-S, SP-16-S,
SP-19-S, SP-21-S, SP-31-S

DoD: TBD

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

1979-1981 1 Required

1982-1991 As Required

8. EQUIPMENT COST ESTIMATE:

Non-Recurring - TBD

Recurring - TBD

Development Schedule - Start Design April 1979; Deliver July 1981

9. POTENTIAL VALUE OF EQUIPMENT:

Each program would provide a unit

10. STATUS:

A review of existing equipment to satisfy requirement is in process

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. Revision D, MMSE Catalog, MMSE (Launch Site), MMC, February 1976
- b. ATR-76(7362)-1, Volume III: Ancillary Equipment Study, STS Users Study (Study 2.2) Final Report, Aerospace, November 1975
- c. K-SM-03.2, KSC, Schedules and Status Summary, Volume 2, Payload Integration, October 1976
- d. Payload Descriptions, Volumes I and II, Level B Data for Automated and Sortie Payloads, July 1975 (SSPD)

12. CONTACT: C. Hart - NASA/KSC

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Multipurpose Work Stands, Access Platforms and Slings (see Note 2,
page 3-5a)

2. EQUIPMENT DESCRIPTION: (See Individual Items for Sketches)

Includes:

- Access Platform, Spacecraft Assembly Stand, Vertical (KMB-MH-06)
- Sling Set, Multipurpose (KMB-MH-27)
- Stand, Spacecraft Assembly, Vertical (KMB-MH-34)
- Stand, Work, Payload Assembly/Test, Horizontal (KMB-AH-30)

3. PHYSICAL CHARACTERISTICS:

- a. Size: }
b. Weight: } See Individual Items

4. PURPOSE AND INTENDED APPLICATION:

a. Capability and Function:

Provide general-purpose lifting capability, spacecraft assembly and work stands, and access platforms at the payload assembly facilities.

b. What Types of Payloads:

Automated, Automated with IUS, Spacelab Equipment

c. What STS Elements are Involved:

IUS, Spacelab

d. Describe Interface Requirements:

TBD

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

See Individual Items

Multipurpose Work Stands, Access Platforms and Slings (Cont'd)

6. IDENTIFY ALL POTENTIAL USERS:

See Individual Items

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

See Individual Items for number required

8. EQUIPMENT COST ESTIMATE:

Non-Recurring - TBD

Recurring - TBD

Development Schedule - See Individual Item

9. POTENTIAL VALUE OF EQUIPMENT:

Common equipment available to all users, avoids each program providing required equipments at the launch site.

10. STATUS:

A review of existing equipment to satisfy requirements is in process

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. Revision D, MMSE Catalog, MMSE (Launch Site), MMC, February 1976
- b. ATR-76(7362)-1, Volume III: Ancillary Equipment Study, STS Users Study (Study 2.2) Final Report, Aerospace, November 1975
- c. K-SM-03.2, KSC, Schedules and Status Summary, Volume 2, Payload Integration, October 1976

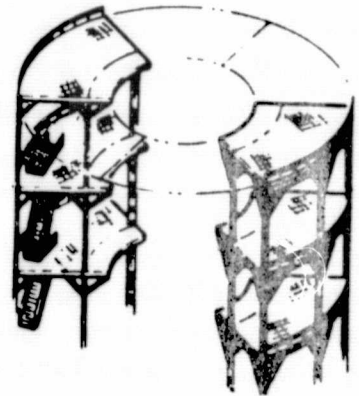
12. CONTACT: C. Hart - NASA/KSC

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Access Platform, Spacecraft Assembly Stand,
Vertical - KMB-MH-06

2. EQUIPMENT DESCRIPTION:

These access platforms will consist of two sets of multilevered scaffolding type platforms. Levels will be approximately 8, 16, and 24 feet. One set will accommodate spacecraft to 15' diameter, having an I.D. of 16' with flip up or bolt on extensions to reduce diameter to 11'. A second set will accommodate spacecraft or kickstages to 10' diameter, having an I.D. of 11', reducible to 6'. The platforms will be modular in construction. Sections will be separated to allow spacecraft removal. Provision for mounting over the 15' diameter base plate of the spacecraft vertical assembly stand will be included in the smaller access platform.



3. PHYSICAL CHARACTERISTICS:

- a. Size:
- b. Weight:

4. PURPOSE AND INTENDED APPLICATION:

a. Capability and Function:

These platforms will be used to access spacecraft in the spacecraft vertical assembly stand and to access kickstages with or without spacecraft in the kickstage assembly/test stand. Can also be used with automated spacecraft which are to be handled in a vertical attitude.

b. What Types of Payloads:

Automated, Automated with IUS

c. What STS Elements are Involved:

IUS

d. Describe Interface Requirements:

TBD

Access Platform, Spacecraft Assembly Stand, Vertical - KMB-MH-06 (Cont'd)

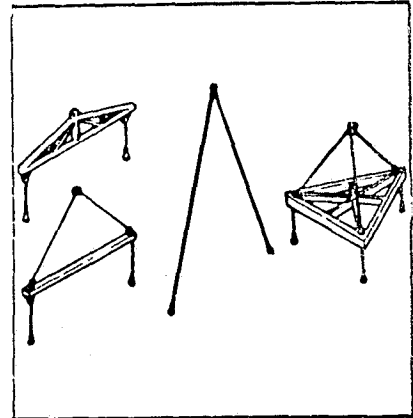
5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:
AS-02-A, AP-02-A, February 1981
6. IDENTIFY ALL POTENTIAL USERS:
All automated payloads with IUS
7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:
1979-1981 1 Required
1982-1991 As Required
8. EQUIPMENT COST ESTIMATE:
Non-Recurring - TBD
Recurring - TBD
9. POTENTIAL VALUE OF EQUIPMENT:
Use user-supplied stands
10. STATUS:
A review of existing equipment to satisfy requirements is in process
11. REFERENCE(S) FOR ADDITIONAL DATA:
 - a. Revision D, MMSE Catalog, MMSE (Launch Site), MMC, February 1976
 - b. ATR-76(7362)-1, Vol. III: Ancillary Equipment Study, STS Users Study (Study 2.2), Final Report, Aerospace, November 1975
 - c. K-SM-03.2, KSC, Schedules and Status Summary, Volume 2, Payload Integration, October 1976
12. CONTACT: C. Hart - NASA/KSC

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Sling Set, Multipurpose - KMB-MH-27

2. EQUIPMENT DESCRIPTION:

This set will consist of a variety of spreader bars, hooks, clevises, drop cables and straps which will be used to lift items for which specific sling sets have not been designated. This would include such items as test or service sets, shipping canisters, and spacecraft for which spacecraft contractors have not provided a special sling.



3. PHYSICAL CHARACTERISTICS:

a. Size:

b. Weight:

4. PURPOSE AND INTENDED APPLICATION:

a. Capability and Function:

This set will provide general-purpose lifting capability in conjunction with cranes or building hoists.

b. What Types of Payloads:

Automated, Automated with IUS, Spacelab Equipment

c. What STS Elements are Involved:

IUS, Spacelab

d. Describe Interface Requirements:

TBD

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

OFT #2, May 1979

6. IDENTIFY ALL POTENTIAL USERS:

All NASA, DoD and Civil Payloads

Sling Set, Multipurpose - KMB-MH-27 (Cont'd)

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:
 - 1979-1981 1 Sets Required
 - 1982-1991 As Required
8. EQUIPMENT COST ESTIMATE:
 - Non-Recurring - TBD
 - Recurring - TBD
 - Development Schedule - Start Design January 1977;
Deliver May 1979
9. POTENTIAL VALUE OF EQUIPMENT:

 Payloads would provide own slings as used in factory
10. STATUS:

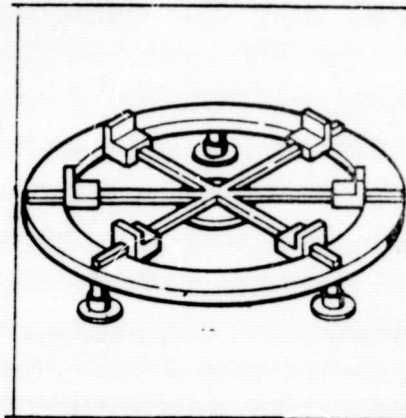
 A review of existing equipment to satisfy requirements is in process
11. REFERENCE(S) FOR ADDITIONAL DATA:
 - a. Revision D, MMSE Catalog, MMSE (Launch Site), MMC, February 1976
 - b. ATR-76(7362)-1, Vol. III: Ancillary Equipment Study, STS Users Study (Study 2.2), Final Report, Aerospace, November 1975
 - c. K-SM-03.2, KSC, Schedules and Status Summary, Volume 2, Payload Integration, October 1976
12. CONTACT: C. Hart - NASA/KSC

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Stand, Spacecraft Assembly, Vertical - KMB-MH-34

2. EQUIPMENT DESCRIPTION:

This stand will consist of a 15' diameter rigid base plate with leveling legs on which are mounted 6 radial rails spaced 60 degrees apart running to the edge of the base plate. Payload interface fittings are mounted on the rails and slide radially to accommodate all spacecraft diameters.



3. PHYSICAL CHARACTERISTICS:

- a. Size: 15-ft diameter (I.D., adjustable)
- b. Weight:

4. PURPOSE AND INTENDED APPLICATION:

- a. Capability and Function:

This stand will support automated spacecraft in the vertical orientation for final assembly and test prior to payload buildup. It will support multiple spacecraft with adapters for multispacecraft buildup and alignment prior to installation on the Tug/IUS. Can also be used with automated spacecraft which are to be handled in a vertical attitude.

- b. What Types of Payloads:

Automated with IUS

- c. What STS Elements are Involved:

IUS

- d. Describe Interface Requirements:

TBD

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

AS-02-A, AP-02-A, February 1981

Stand, Spacecraft Assembly, Vertical - KMB-MH-34 (Cont'd)

6. IDENTIFY ALL POTENTIAL USERS:

All automated payloads with IUS

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

1979-1981 1 Required

1982-1991 As Required

8. EQUIPMENT COST ESTIMATE:

Non-Recurring - TBD

Recurring - TBD

Development Schedule - Start Design November 1978;
Deliver February 1981

9. POTENTIAL VALUE OF EQUIPMENT:

Each payload provides own

10. STATUS:

A review of existing equipment to satisfy requirements is in process

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. Revision D, MMSE Catalog, MMSE (Launch Site), MMC, February 1976
- b. ATR-76(7362)-1, Vol. III: Ancillary Equipment Study, STS Users Study (Study 2.2), Final Report, Aerospace, November 1975
- c. K-SM-03.2, KSC, Schedules and Status Summary, Volume 2, Payload Integration, October 1976

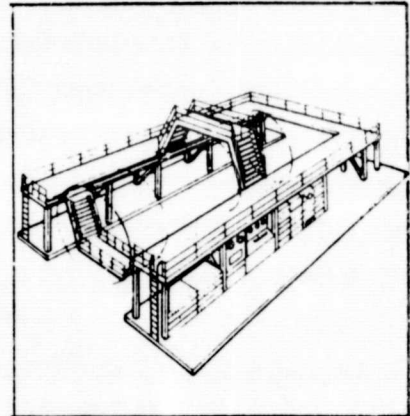
12. CONTACT: C. Hart - NASA/KSC

i. NAME AND IDENTIFYING NUMBER:

Stand, Work, Payload Assembly/Test, Horizontal - KMB-AH-30

2. EQUIPMENT DESCRIPTION:

The workstand is a horizontal support structure which supports and provides access to individual and integrated automated payloads. Retention fittings are TBD in terms of type, quantity, and location. Access is provided for the entire length of the workstand on both sides as well as the full width at both ends, and to all required positions within the envelope of the workstand. The stand includes cable trays for routing of electrical and fluid lines and interface panels for simulating the orbiter to payload interfaces.



3. PHYSICAL CHARACTERISTICS:

a. Size:

b. Weight:

4. PURPOSE AND INTENDED APPLICATION:

a. Capability and Function:

This stand is used to provide access and support to automated payloads for assembly, disassembly, and selected testing.

b. What Types of Payloads:

Automated and Planetary

c. What STS Elements are Involved:

None

d. Describe Interface Requirements:

TBD

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

TBD

Stand, Work, Payload Assembly/Test, Horizontal - KMB-AH-30 (Cont'd)

6. IDENTIFY ALL POTENTIAL USERS:

All automated payloads (compatible with horizontal attitude)
without IUS

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

1979-1981 ---

1982-1991 1 Required

8. EQUIPMENT COST ESTIMATE:

Non-Recurring - TBD

Recurring - TBD

Development Schedule - Start Design February 1981;
Deliver July 1983

9. POTENTIAL VALUE OF EQUIPMENT:

Each payload provides own stands and orbiter interface
simulation

10. STATUS:

A review of existing equipment to satisfy requirements is in
process

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. Revision D, MMSE Catalog, MMSE (Launch Site), MMC, February 1976
- b. ATR-76(7362)-1, Vol. III: Ancillary Equipment Study, STS Users
Study (Study 2.2), Final Report, Aerospace, November 1975
- c. K-SM-03.2, KSC, Schedules and Status Summary, Volume 2,
Payload Integration, October 1976

12. CONTACT: C. Hart - NASA/KSC

NAME OF ITEM AND IDENTIFYING NUMBER:

Cargo Integration Test Equipment (CITE) (see Note 3, page 3-5a)

2. EQUIPMENT DESCRIPTION:

The cargo integration test equipment is the horizontal and vertical workstand which is used to check out a total Shuttle cargo and demonstrate payload inter compatibility and cargo-to-Shuttle compatibility. (See following pages for pictorial concepts.)

3. PHYSICAL CHARACTERISTICS:

a. Size:

b. Weight:

4. PURPOSE AND INTENDED APPLICATION:

a. Function and Capability:

Concepts for the CITE are under development and features of the IVE concept are included. For this draft IVE capabilities will be listed and updated as the CITE data are made available.

Provides an exact replica of the cargo bay geometry to verify that installed payloads have prescribed clearances to orbiter structure.

Verifies that payload mountings, connections to orbiter servicing and checkout provisions, and locations of access panels and payload umbilicals are correctly fabricated and positioned to mate with orbiter interfaces.

(1) Mechanical

- (a) Provides payload heat exchange at 5,200, 21,500, and 29,000 Btu/hr at 45°F (7.2° C) maximum temperature.
- (b) Leak checking of fluid systems (pressure decay method)

(2) Electrical

- (a) Primary (7 KW) and secondary (5 KW) power at 27-32 vDC and 24-32 vDC.
- (b) Fuel cell software simulation.

Cargo Integration Test Equipment (CITE) - Cont'd

(3) Avionic

- (a) Payload Specialist Station (PSS) console for performance of payload orbital checkout and control functions.
- (b) Mission Specialist Station (MSS) console for verification of orbiter payload control functions and adequacy of caution and warning provisions.
- (c) Control, monitoring, and routing of signal flow to/from payload to GSE and data processing equipment.
- (d) Flight software validation utilizing orbiter TLM PCM system.

b. What Types of Payloads:

Automated, Automated with IUS, Spacelab

c. What STS Elements are Involved:

Orbiter Mechanical and Functional Simulation

d. Describe Interface Requirements:

Cargo to Orbiter - Mechanical
Structural
Electrical
Electronic

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

OFT #2, May 1979

6. IDENTIFY ALL POTENTIAL USERS:

All NASA, DoD and Civil Payloads

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED

1979-1981	1 Set Required	SAEF (Vertical CITE) and O&C Building
1982-1991	1 Additional for WTR	(Horizontal CITE)

Cargo Integration Test Equipment (CITE) - Cont'd

8. EQUIPMENT COST ESTIMATE:

Non-Recurring - TBD

Recurring - TBD

Development Schedule - Start Design July 1977; Deliver March 1979

9. POTENTIAL VALUE OF EQUIPMENT:

Users would have to provide own verification equipment or use actual orbiter which would affect schedule.

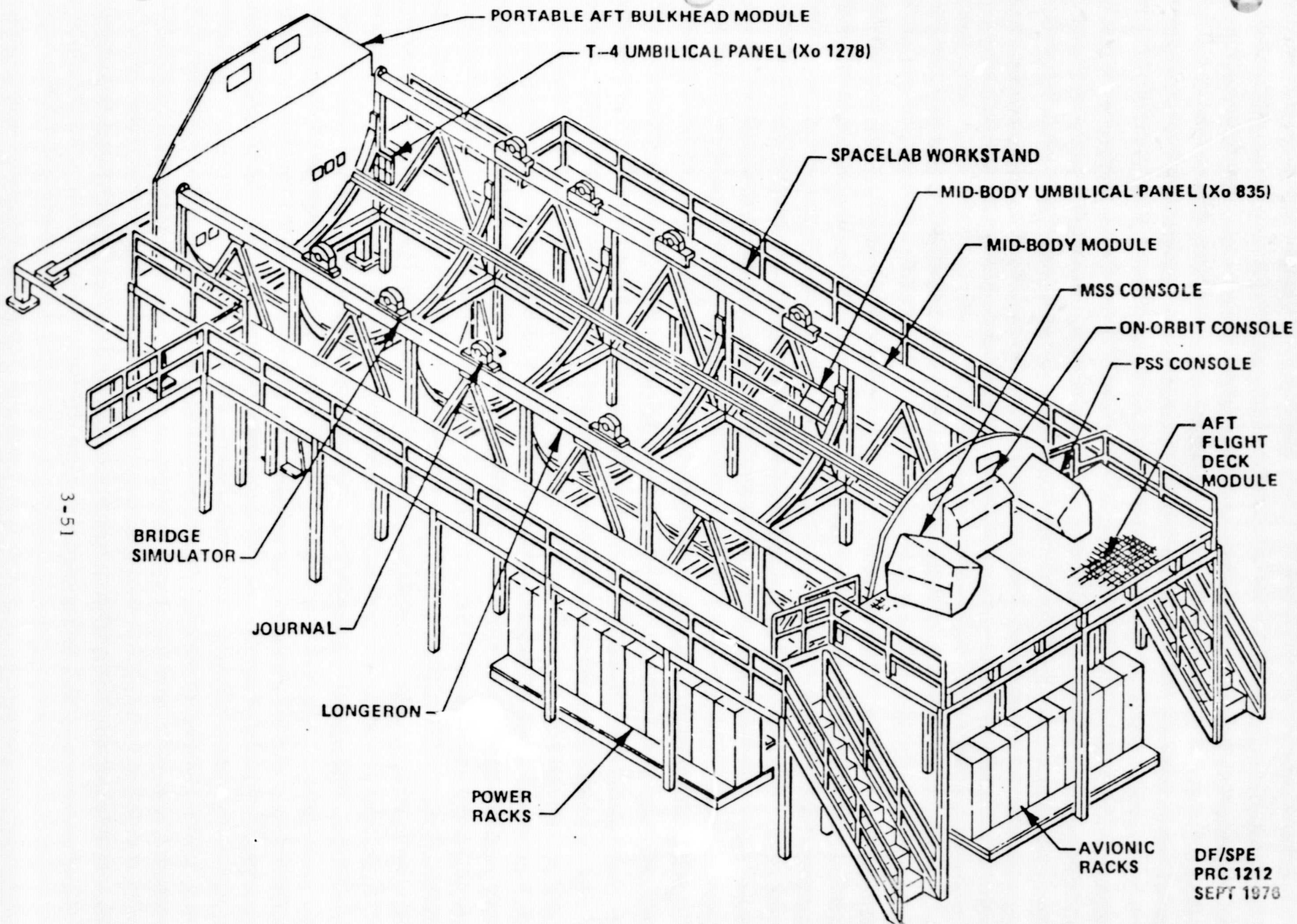
10. STATUS:

Funded in FY 1977; concept development in process.

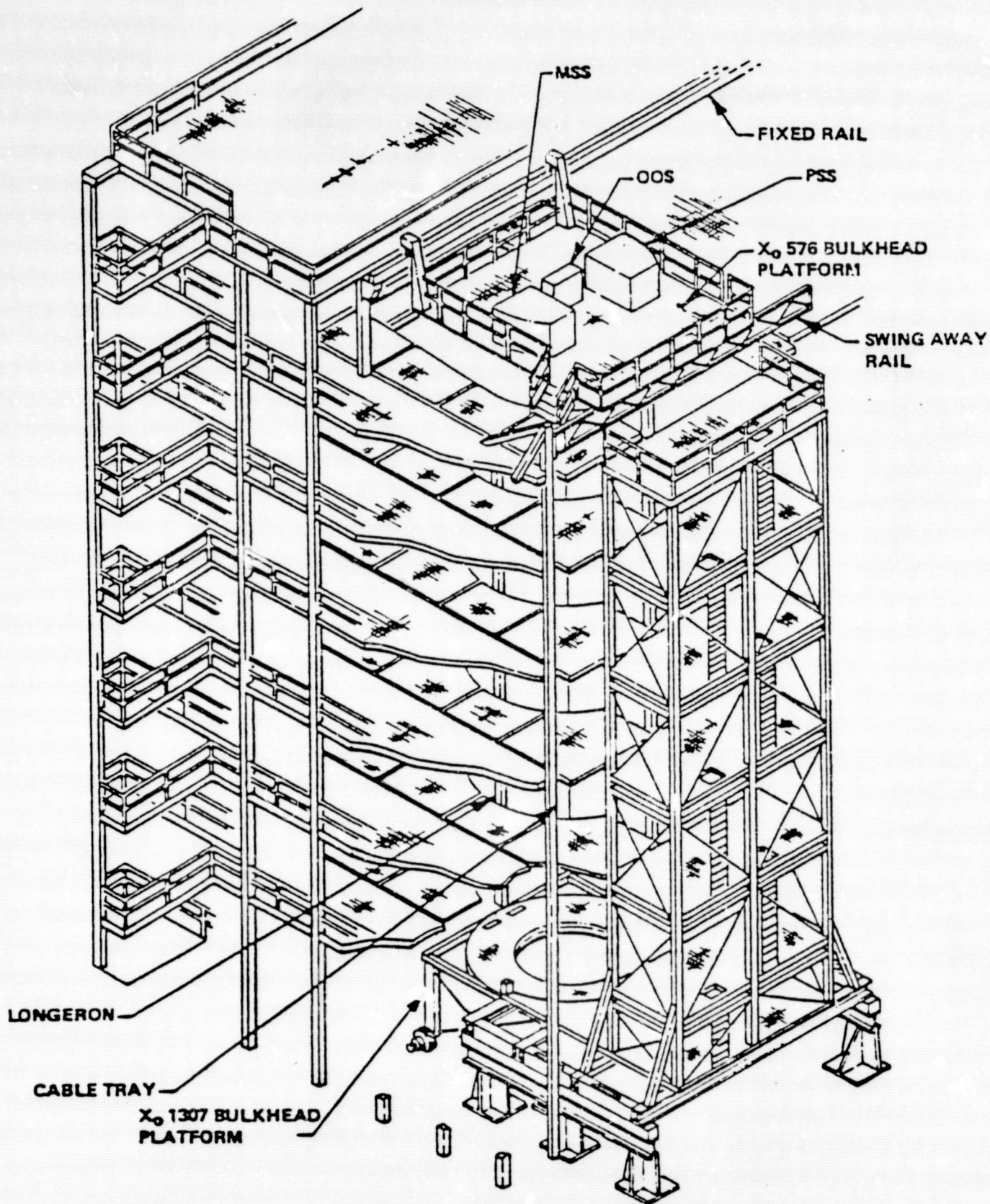
11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. Briefing, Interface Verification Equipment Study (NAS G-14000 CCA-140) - IVE Concept, Rockwell International, May 5, 1975
- b. STS Users Study (Study 2.2) Final Report, Volume III: Ancillary Equipment Study, ATR-76(7362)-1
- c. SAMSO-TR-76-103, DoD Space Transportation System Payload Interface Support Study, Book 2, Final Report, MDAC, December 1976
- d. K-SM-03.2, KSC, Schedules and Status Summary, Volume 2, Payload Integration, October 1976

12. CONTACT: C. Hart - NASA/KSC



HORIZONTAL CITE MODULAR CONCEPT INSTALLED IN SPACELAB WORKSTAND



VERTICAL CITE MODULAR CONCEPT INSTALLED IN
 UPPER STAGE WORKSTAND

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Outsized Payload Transportation System

2. EQUIPMENT DESCRIPTION:

The outsized transportation system is required to transport payloads greater than 3.96 m (13 ft) in diameter. Transport requirements include manufacturer to launch site, KSC to WTR, contingency landing to launch site, and integration facility to launch site. Outsized payloads requiring transportation include: (1) integrated Spacelab (lab or lab plus pallet); and (2) large diameter automated spacecraft. The outsized transportation system will be required in TBD. Uses estimated for the system from 1980 through 1991 are TBD. Based on use rate up to 20/year, it is estimated that one system will be adequate. Analyses performed to date have evaluated several means of providing this capability including rail, road, barge, and aircraft. Of these alternatives, rail and road were eliminated because of limitations on payload sizes and availability of rail sites. Barge transportation was not recommended because of higher operating costs compared with air transport, added hardware inventory, and constraints on location of large diameter spacecraft manufacturing sites.

3. PHYSICAL CHARACTERISTICS:

TBD

4. PURPOSE AND INTENDED APPLICATION:

a. Capability and Function:

TBD

b. What Types of Payloads:

Spacelab, Large (Greater Than 13 ft Dia) Automated

c. What STS Elements Are Involved:

Spacelab

d. Describe Interface Requirements:

TBD

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

Spacelab Possibly 1979

6. IDENTIFY ALL POTENTIAL USERS:

All Spacelab Programs, Future Large Automated Spacecraft

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

1980-1991 TBD, 1 Required

8. EQUIPMENT COST ESTIMATE:

TBD

9. POTENTIAL VALUE OF EQUIPMENT:

TBD

10. STATUS:

Transportation System For Outsized Payloads is Being
Evaluated by NASA

11. REFERENCE(S) FOR ADDITIONAL DATA:

TBD

12. CONTACT: TBD

3.2

SPACEBORNE EQUIPMENT

1. Pointing and Stabilization Systems
 - a. Small Instrument Stabilization Systems (SIPS)
 - b. Annular Suspension and Pointing System (ASPS)
 - c. Instrument Pointing System (IPS)
2. Electrical Cabling
 - a. Automated Payload/IUS Cabling - 330-03-09-02
 - b. Automated Payload/Orbiter Cabling - 330-03-09-01
3. Contamination Monitoring
 - a. Induced Environment Contamination Monitor (IECM)
 - b. Trace Gas Analyzer
4. Manned Maneuvering Unit
5. Auxiliary Power Systems
 - a. Auxiliary Payload Power System (APPS)
 - b. Multi-Discipline Auxiliary Payload Power System (MAPPS)
6. Payload Specialist Station
7. RTG Cooling Unit
8. Second Ku-Band Antenna
9. Cradle/Non-IUS Payload
10. Multi-Use Fluid Lines Kit
11. Umbilical Connector
12. Avionics Equipment
 - a. Multiplexer/Demultiplexer
 - b. Electrical Isolation, Conditioning, and Distribution Assembly
 - c. Dedicated Recorder
 - d. PCM Unit
 - e. DC-DC Converter/Regulator

NAME OF ITEM AND IDENTIFYING NUMBER:

Pointing and Stabilization Systems

2. EQUIPMENT DESCRIPTION:

Includes: (1)

- Instrument pointing system (IPS) or
- Small instrument pointing system (SIPS) or
- Annular suspension and pointing system (ASPS)

3. PHYSICAL DESCRIPTION:

See individual items

4. PURPOSE AND INTENDED APPLICATION:

a. Capability and function:

Pointing, control, and stabilization systems are required for many Spacelab payloads to supplement basic capabilities provided by the Orbiter. The Orbiter is capable of pointing payloads to approximately 0.5 deg. (with P/L mounted sensor) of desired orientation. Payloads with requirements less than this must provide separate equipment for acquiring targets and for maintaining desired orientations. Of 154 Spacelab payloads defined in SSPD, 108 have pointing or stabilization requirements that exceed Orbiter capabilities.

b. What types of payloads:

Spacelab

c. What STS elements are involved:

Orbiter, Spacelab

d. Describe interface requirements:

See individual item

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

Spacelab 2 mission

- (1) It is expected that one of these pointing systems will be built.

6. IDENTIFY ALL POTENTIAL USERS:

Approximately 36 to 50 percent of the NASA and Civil Spacelab payloads

DoD STP Spacelab experiments - Precision Release Accuracy Test
- LIDAR
- Earth Limb Measurements Test

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

1979-1981 9-12 per year
1982-1991 10-23 per year

8. EQUIPMENT COST ESTIMATE:

See individual item

9. POTENTIAL VALUE OF EQUIPMENT:

Payloads with pointing requirements less than 0.5 degrees must provide separate equipment for acquiring targets and maintaining desired orientations.

10. STATUS:

JPL is evaluating concepts (evaluation complete, report to be published.

11. REFERENCE(S) FOR ADDITIONAL DATA:

See individual item

12. CONTACT:

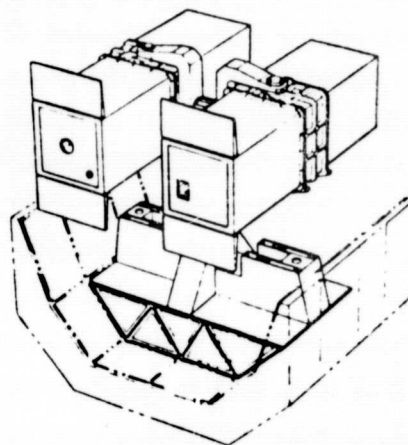
Rein Ise NASA/MSFC

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Small Instrument Pointing System (SIPS)

2. EQUIPMENT DESCRIPTION:

The Small Instrument Pointing System will be a three-axis stable platform to provide pointing, control, and stabilization for Spacelab payloads with requirements which exceed the orbiter capability of approximately 0.5 (with P/C mounted sensor) deg of the desired orientation.



3. PHYSICAL CHARACTERISTICS:

a. Size:

b. Weight:

4. PURPOSE AND INTENDED APPLICATION:

a. Function and Capability:

This SIPS would be optimized to handle payloads less than 1 m (3.3 ft) in diameter and less than 400 kg (880 lb) in weight in each canister. The SIPS gimbal system accommodates two instruments simultaneously and has the following general characteristics:

(1) Instrument Accommodation (Size) -

Envelope: 0.9 x 0.9 x 3.1 m (2.95 x 2.95 x 10 ft),
Weight: 340 kg (750 lb)

(2) Pointing Stability -

Most precise pitch and yaw requirement: ± 0.25 arc-sec/
30 min; Objective: ± 0.1 arc-sec/5 min.

Most precise roll requirement: ± 15 arc-sec/30 min;
Objective: ± 15 arc-sec/30 min.

(3) Gimbal System -

Range: Hemispherical
Coarse Azimuth: ± 180 deg or more
Fine Up/Down: 0 to 120 deg
Fine Right/Left: ± 10 deg
Maneuver Rates: Greater than 0.5 deg/sec
Pick-Off Accuracy: Greater than 0.1 deg

Small Instrument Pointing System (SIPS) - Cont's

- b. What Types of Payloads:
 Spacelab
- c. What STS Elements are Involved:
 Orbiter, Spacelab
- d. Describe Interface Requirements:
 Spacelab Pallet
- 5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

 TBD 1979-1980
- 6. IDENTIFY ALL POTENTIAL USERS:

 Approximately 36 to 50 percent of the Spacelab payloads (See Reference a)
 DoD STP Spacelab experiments - Precision Release Accuracy Test
 - LIDAR
 - Earth Limb Measurements Test
- 7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

 1979-1981 9-12 per year
 1982-1991 10-23 per year
- 8. EQUIPMENT COST ESTIMATE:

 Non-Recurring - TBD
 Recurring - TBD
 Development Schedule - TBD
- 9. POTENTIAL VALUE OF EQUIPMENT:

 Payloads with requirements less than 0.5 degrees must provide separate equipment for acquiring targets and maintaining desired orientations.
- 10. STATUS:

 JPL is evaluating concepts (evaluation complete, report to be published)
- 11. REFERENCE(S) FOR ADDITIONAL DATA:
 - a. MCR-76-202, MMC Final Report, Volume II, Book 1, MMSE
 June 1976

- b. STP Spacelab Utilization Study Final Report, 30297-6001-RU-00
Nov. 15, 1976 TRW

12. CONTACT:

TBD

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Annular Suspension Pointing System (ASPS) TBD

2. EQUIPMENT DESCRIPTION: (See Figure)

The annular suspension and pointing system will be a three-axis stable platform to provide pointing, control and stabilization for spacelab payloads with requirements which exceed the orbiter capability of approximately 0.5 deg (with P/L mounted sensor) of the desired orientation.

3. PHYSICAL CHARACTERISTICS.

a. Size: TBD

b. Weight: TBD

4. PURPOSE AND INTENDED APPLICATION:

a. Function and Capability:

The ASPS is a modular payload pointing system comprised of two major subassemblies, namely a gimbal subassembly and a vernier subassembly, with associated peripheral equipment such as a miniprocessor and status information panel. The ASPS gimbal subassembly (AGS) provides the slewing and "coarse" pointing capability of the system, as well as an inherent backup pointing mode should problems develop in the vernier subsystem. The ASPS vernier subassembly (AVS) permits sub arc second pointing of the payload as well as its complete isolation from carrier vehicle disturbances through the use of noncontacting magnetic bearing actuator and sensor elements. The complete ASPS is expected to provide payload stability better than 0.1 arc second in the OFT configuration and, when coupled with a quality sensor, the position accuracy should approach that of the sensor. The unique arrangement of gimbal and vernier subsystems permits the utilization of ASPS for stellar, solar, and terrestrial observations.

The ASPS can accommodate a total payload weight of 800 kilograms, which, allowing 200 kilograms for structure and sensors, equates to accommodating a 600-kilogram science payload.

The ASPS interfaces with the Spacelab Electrical Power Distribution Unit (EPDS) and provides about 500 watts of power to the payload.

The ASPS also interfaces with the CDMS through a Remote Acquisition Unit (RAU) and is provided the following capabilities by the CDMS:

A. Decoding and transmission of on-board and ground-generated commands.

B. Mode control and sequencing.

- C. Mass storage for star catalogs and calibration data.
- D. Formatting of data for storage, display and/or downlink.

Payload interfaces with Spacelab data systems are satisfied by an RAU located on the ASPS payload mounting plate.

On-board commands are generated by the ASPS miniprocessor which provides control loop closures between payload position and rate sensors and ASPS actuators. The ASPS will be provided with a three-axis inertial reference unit; however, payload position sensors are considered to be mission dependent, and will thus be furnished by the users.

The two-axis AGS permits a hemispherical payload viewing angle with the capability of doing horizon-to-horizon ground tracking of a fixed point on the Earth's surface. Each axis is equipped with a 33 N-m brushless d.c. direct drive torquer with a redundant operating mode, and adjustable hard stops capable of dissipating the energy of an 800 kilogram payload having been accelerated to maximum velocity by the torquers. This will prevent the payload from striking the Orbiter or other equipment mounted nearby.

A separation mechanism will be provided between the AGS interface plate and the AVS to prevent undue loads from being applied to the AGS bearings during launch and landing.

- b. What Types of Payloads:

Spacelab

- c. What STS Elements are Involved:

Orbiter, Spacelab

- d. Describe Interface Requirements:

Power

C & DH Interface

- 5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

Spacelab 2 Mission -- 1980

- 6. IDENTIFY ALL POTENTIAL USERS:

Approximately 36 to 50 percent of the Spacelab payloads

DoD, STP, Spacelab experiments -- (solar, stellar and terrestrial observations)

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

1979-1981	9-12 per year
1982-1991	10-23 per year

8. EQUIPMENT COST ESTIMATE:

Non-Recurring -- TBD

Recurring -- TBD

Development Schedule -- Start design July 1976; deliver engineering model April 1979.

9. POTENTIAL VALUE OF EQUIPMENT:

Payloads with requirements less than 0.5 degrees must provide separate equipment for acquiring targets and maintaining desired orientations.

10. STATUS:

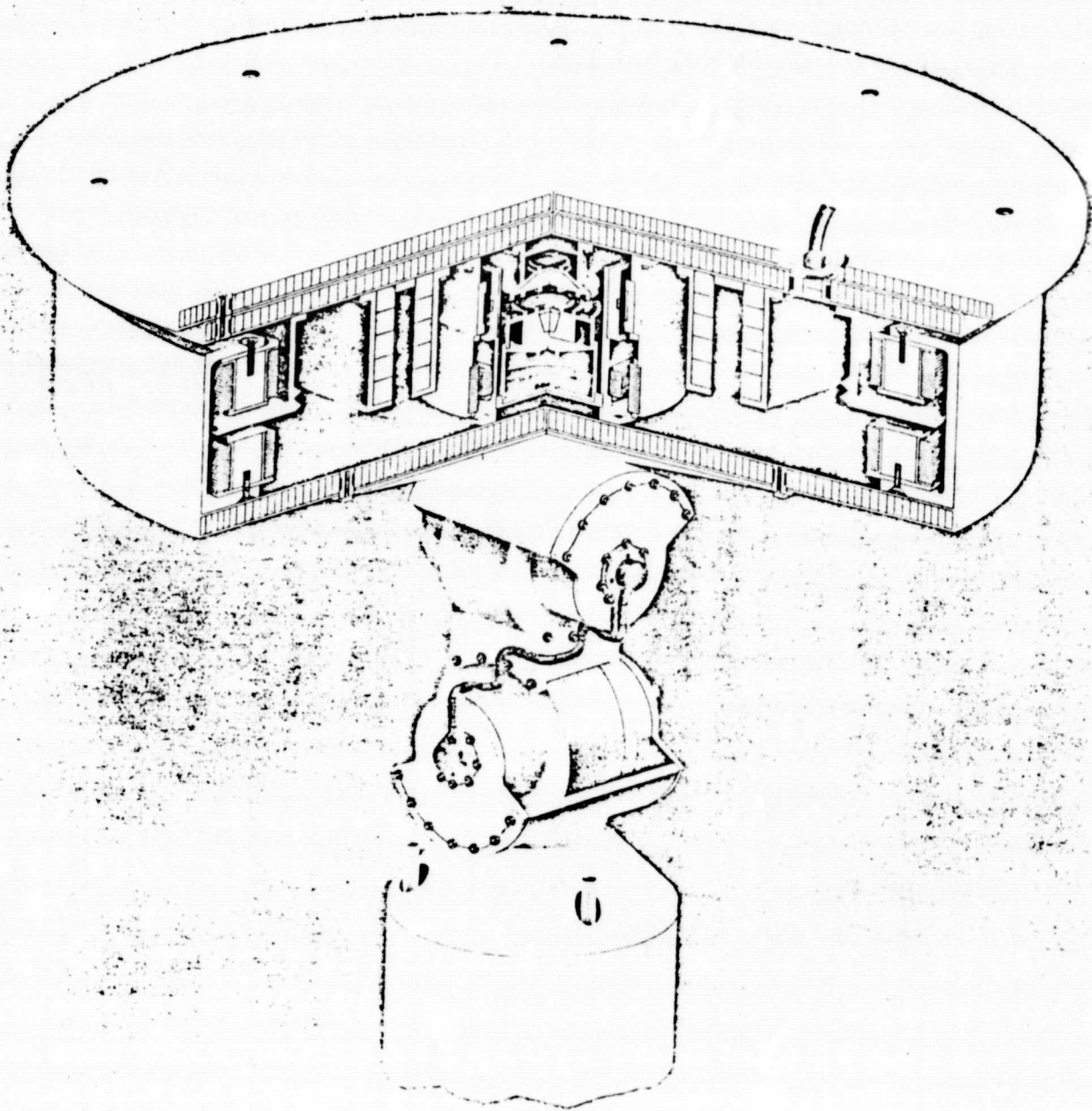
Engineering model ASPS is being developed by NASA/Langley to fly on an OFT mission. Acquisition of flight unit for SL-2 is planned.

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. Annular Suspension Pointing System for Space Experiments and Predicted Accuracy, NASA TR 448.
- b. STP Spacelab Utilization Study Final Report, 30297-6001-RU-00 Nov. 15, 1976 TRW

12. CONTACT:

Rein Ise NASA/MSFC



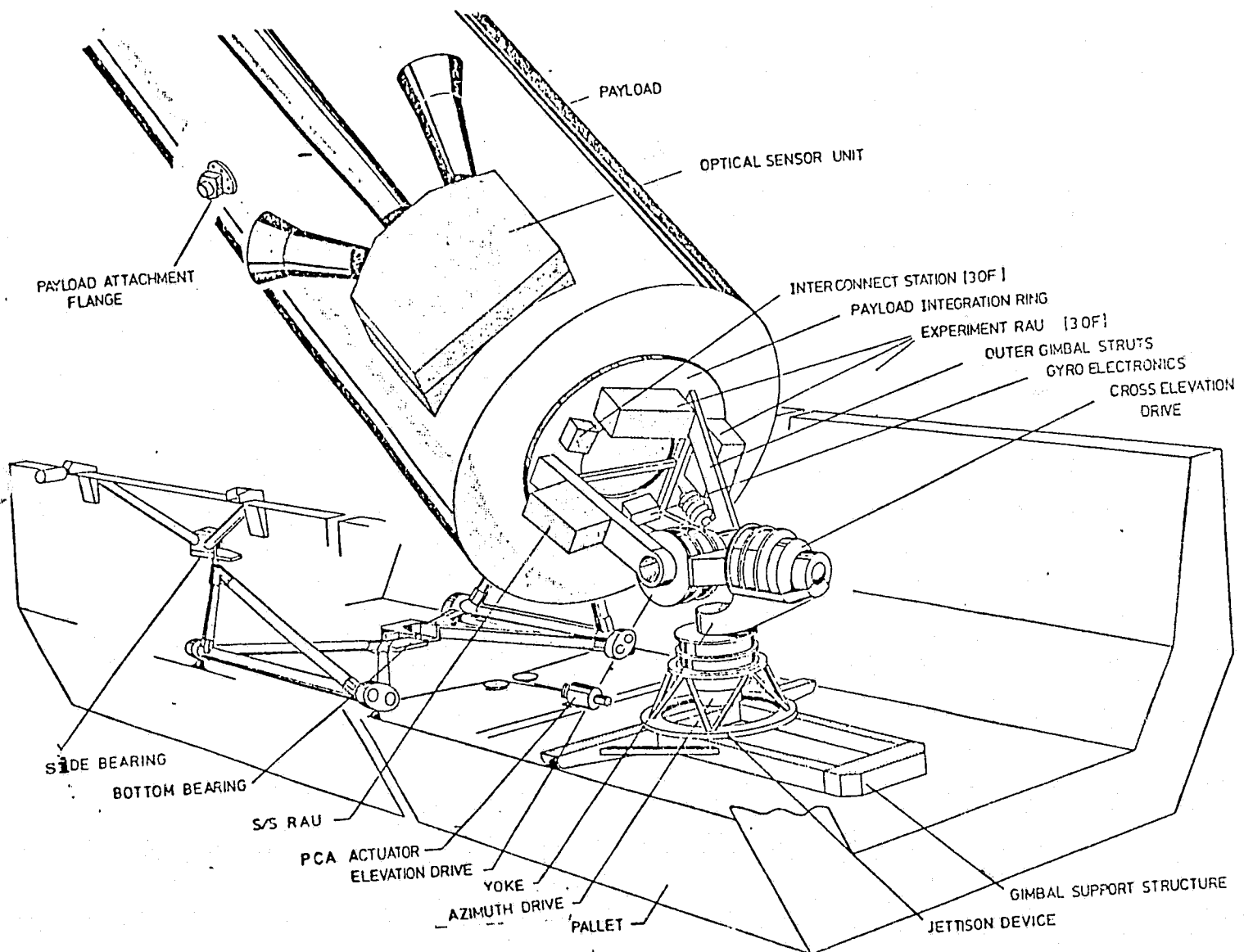
ANNULAR SUSPENSION AND POINTING SYSTEM
(ASPS)

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Instrument Pointing System No. TBD

2. EQUIPMENT DESCRIPTION:

The Instrument Pointing System (IPS) provides precision pointing for payloads which require greater pointing accuracy and stability than is provided by the orbiter. The IPS can accommodate a wide range of payload instruments of different sizes and weight.



3. PHYSICAL CHARACTERISTICS:

- a. Size: 1.5m (5 ft. long)
- b. Weight: 750 Kg (1654 lbs)

4. PURPOSE AND INTENDED APPLICATION:

a. Capability and Function:

The Europeans are now considering an IPS as part of the Spacelab program. The Spacelab IPS is shown in the Figure. The IPS is referred to as an inside-out-gimbal (IOG) system because of its configuration. The IPS provides three-axis attitude control and stabilization for experiments up to 3000 kg (6600 lb) in weight and 2 m (6.6 ft) diameter. The IPS bias or reference error is less than 2 arc-sec (design goal of 0.8 arc-sec) in pitch and yaw and less than 40 arc-sec in roll (design goal of 15 arc-sec). The quiescent stability error is less than 1.2 arc-sec (design goal of 0.5 arc-sec) in pitch and yaw and less than 25 arc-sec (design goal of 10 arc-sec) in roll.

Attitude control of the payload is based on rate integrating gyros (RIG) error signals processed within the Spacelab computer (CDMS) to generate command signals to DC torquers in each gimbal axis. The RIG package is located on the outer gimbal and hence, aside from distortion of flexures occurring within the payload, maintains the payload as an inertially stabilized platform. To correct for gyro drift and to provide an absolute attitude reference, a package of optical sensors is also included. In a stellar mission this would comprise three star trackers, and in a solar mission one star tracker would be replaced by a solar sensor. The package will normally be located on the payload to assure the optimum viewing configuration and to minimize misalignments between star-tracker and experiment line-of-sight axis for those payloads relying on mechanical alignment. Mechanical mounting methods do not allow pointing accuracies of the order of a few arc seconds to be achieved. Therefore, the optical sensors allow for the input of a simulated star image from the payload into the sensor or an electrical signal as an indication of the experiment line-of-sight (LOS).

A correction for the offset from the star-tracker LOS is then made in the software processing of the star-tracker data in the CDMS. Alignment errors between the experiment line-of-sight and the reference guide star are in this way minimized, and the best possible pointing accuracy within the inherent capabilities of the star-tracker and experiment optics is achieved.

b. What Types of Payloads:

Spacelab

c. What STS Elements are Involved:

Orbiter, Spacelab

d. Describe Interface Requirements:

Spacelab Pallet

Power

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

Spacelab 2 Mission -- 1980

6. IDENTIFY ALL POTENTIAL USERS:

Approximately 36 to 50 percent of the NASA and Civil Spacelab payloads (see reference a).

DoD, STP, Spacelab experiments -- (solar and stellar).

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

1979-1981 9-12 per year

1982-1991 10-23 per year

8. EQUIPMENT COST ESTIMATE:

Non-Recurring - TBD

Recurring - TBD

Development Schedule - Delivered for use with spacelab 2 mission

9. POTENTIAL VALUE OF EQUIPMENT:

Payloads with pointing requirements less than 0.5 deg. must provide separate equipment for acquiring targets and maintaining desired orientations.

10. STATUS:

Being developed by ESA.

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. MCR-76-202, MMC Final Report, Vol II, Book 1, MMSE
June 1976.
- b. Spacelab Payload Accommodation Handbook, NASA/ESA 1976.
- c. STP Spacelab Utilization Study Final Report, 30297-6001-RU-00
Nov. 15, 1976, TRW.
- d. IPS Specification, IPS-DS-SP-0001, December 23, 1976.

12. CONTACT:

Rein Ise NASA/MSFC

↓

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Electrical Cabling

2. EQUIPMENT DESCRIPTION:

Includes:

- Automated Payload/IUS Cabling - 330-03-09-02
- Automated Payload/Orbiter Cabling - 330-03-09-01

3. PHYSICAL CHARACTERISTICS:

- a. Size:
- b. Weight: See individual items

4. PURPOSE AND INTENDED APPLICATION:

a. Function and Capability:

Electrical cabling is required to interface payloads with carrier-provided services. The Spacelab provides standard cabling to distribute electrical services to Spacelab payloads. The remaining two carriers (Orbiter and IUS) provide standard interfaces for automated payload cabling. Cabling should be provided to interface automated payloads with Orbiter or IUS. Cabling would be installed and removed, as required, to minimize weight penalties. One set of each type of cabling (Orbiter and IUS) would be required for each Orbiter and one spare.

b. What Types of Payloads:

Automated, Automated with IUS

c. What STS Elements are Involved:

Orbiter, IUS

d. Describe Interface Requirements:

The Orbiter provides standard electrical interfaces for payloads at stations X_O 576, 695, and 1307 (Ref 2). Station X_O 576 is the primary electrical interface for Orbiter services. Payload interfaces with the Orbiter data, communication, MSS, PSS, G&D, timing, C&W, etc, are accomplished via this panel. Current wiring interfaces provided at this panel included: 228 twisted-shielded-pair (TSP), 90 twisted pair (TP), 29 twisted-shielded-five-conductor (TS5C), and 18 coax connectors. Station X_O 695

is the primary power interface for payloads. In addition, secondary power is also available on the right hand bay sidewall. Station X₀ 1307 provides two separate power interfaces for payloads and also provides standard panels for interfacing with the T-0 ground umbilical.

The Spacelab provides a standard cabling and distribution system for interfacing payloads with Spacelab/Orbiter-provided services. The Spacelab provides distribution cabling for electrical power, a data bus for command and monitoring, and hardwired C&W. This cabling interfaces the payload components via distribution boxes and switch panels located in the Spacelab module and pallets. (See Ref. 48)

The IUS does not provide for any electrical interfacing cabling to the payload. However, it does assume that space for this cabling will be made available within the IUS and/or its cradle.

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

See Individual Item

6. IDENTIFY ALL POTENTIAL USERS:

See Individual Item

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

See Individual Item

8. EQUIPMENT COST ESTIMATE:

See Individual Item

9. POTENTIAL VALUE OF EQUIPMENT:

Savings of approximately 67% when compared to payload-unique cabling

10. STATUS:

Not Currently Funded

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. MCR-76-202, Catalog MMSE, MMC, June 1976
- b. MCR-76-202, Volume III, Final Report MMSE, Project Cost Estimates, MMC, June 1976
- c. MCR-76-202, Volume II, Book 1, Final Report MMSE, Requirements, Definition, and Design Analysis, MMC, June 1976
- d. ATR-76(7362)-1, Volume III: Ancillary Equipment Study, STS Users Study (Study 2.2) Final Report, Aerospace, November 1975
- e. SAMSO-TR-76-103, DoD Space Transportation System Payload Interface Support Study Final Report, MDAC, December 1976
- f. SAMSO-TR-76-212, Volume II, DoD Shuttle Integration Support Study Final Report, Rockwell International, November 1976
- g. DoD Shuttle Integration Support Study Final Briefing, 12th Technical Review, 8 December 1976, Rockwell International F04701-75-C-0184)

12. CONTACT

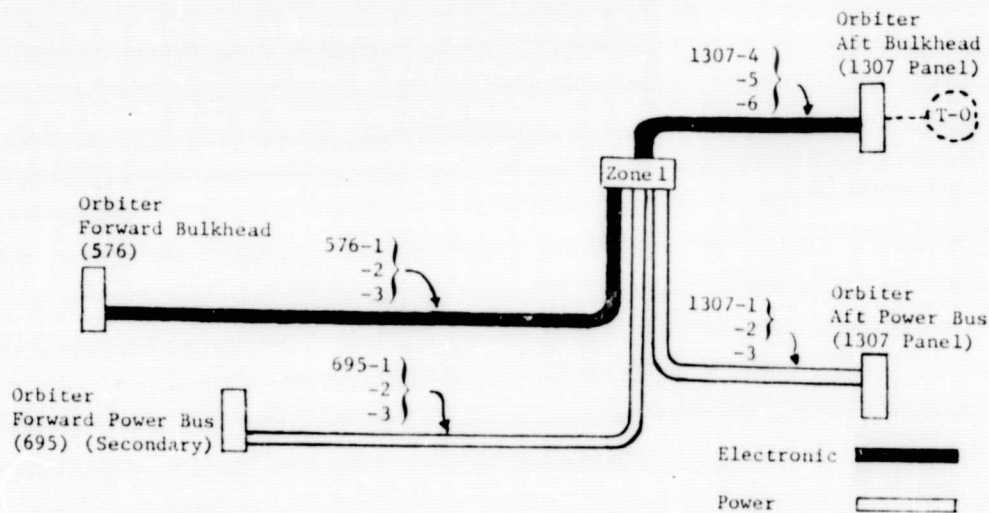
J. Heberlig, NASA/JSC

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Automated Payload/IUS Cabling 330-03-09-02

2. EQUIPMENT DESCRIPTION:

A concept for IUS/automated payloads is shown in the figure. Each cable set would require development of four cables and production of 12, because as many as three multiple payloads might be accommodated on an IUS flight. Cables would be installed/removed as required to minimize weight penalties associated with common cabling. One cable set would be required for each orbiter plus one spare.



3. PHYSICAL CHARACTERISTICS:

CABLE SET COMPONENTS	Signals/Power				Equivalent Length, ft	Weight lb
	TSP	TS5C	TP	COAX		
576-1,2&3	36	3	0	8	65	102 each
695-1,2&3	0	0	2	0	57	2 each
1307-1,2&3	0	0	2	0	17	1 each
1307-4,5&6	36	3	0	0	17	22 each

Automated Payload/IUS Cabling 330-03-09-02 (Cont'd)

4. PURPOSE AND INTENDED APPLICATION:

a. Function and Capability:

Payloads require electrical cabling to interface with the orbiter-provided services. See sketch and table of physical characteristics above.

b. What Types of Payloads:

Automated with IUS

c. What STS Elements are Involved:

Orbiter, IUS

d. Describe Interface Requirements:

The orbiter provides standard electrical interfaces for payloads at stations X_O 576, 695, and 1307. Station X_O 576 is the primary electrical interface for orbiter services. Payload interfaces with the orbiter data, communication, MSS, PSS, C&D, timing, C&W, etc., are accomplished via this panel. Current wiring interfaces provided at this panel include: 228 twisted-shielded-pair (TSP), 90 twisted pair (TP), 29 twisted-shielded-five-conductor (TS5C), and 18 coax connectors. Station X_O 695 is the primary power interface for payloads. In addition, secondary power is also available on the right hand bay sidewall. Station X_O 1307 provides two separate power interfaces for payloads and also provides standard panels for interfacing with the T-O ground umbilical.

The IUS does not provide for any electrical interfacing cabling to the payload. However, it does assume that space for this cabling will be made available within the IUS and/or its cradle.

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

AS-02-A, AP-02-1, April 1981

6. IDENTIFY ALL POTENTIAL USERS:

All NASA and Civil automated payloads with IUS (See Reference a and c)
DoD Payloads: DSP, FSC, GPS (See Reference g)

Automated Payload/IUS Cabling 330-03-09-02 (Cont'd)

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

20 NASA payloads through 1983

3 DoD payloads, flight rate TBD

8. EQUIPMENT COST ESTIMATE:

Non-Recurring - \$30,000

Recurring - \$205,600

Development Schedule - Start design July 1978, Deliver July 1980

9. POTENTIAL VALUE OF EQUIPMENT:

Savings of approximately 67% when compared to payload-unique cabling.

10. STATUS:

Not currently funded

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. MCR-76-202, Catalog MMSE, MMC, June 1976
- b. MCR-76-202, Volume III, Final Report MMSE, Project Cost Estimates, MMC, June 1976
- c. MCR-76-202, Volume II, Book 1, Final Report MMSE, Requirements, Definition, and Design Analysis, MMC, June 1976
- d. ATR-76(7362)-1, Volume III: Ancillary Equipment Study, STS Users Study (Study 2.2) Final Report, Aerospace, November 1975
- e. SAMSO-TR-76-103, DoD Space Transportation System Payload Interface Support Study Final Report, MDAC, December 1976
- f. SAMSO-TR-76-212, Volume II, DoD Shuttle Integration Support Study Final Report, Rockwell International, November 1976
- g. DoD Shuttle Integration Support Study Final Briefing, 12th Technical Review, 8 December 1976, Rockwell International F04701-75-C-184)

12. CONTACT

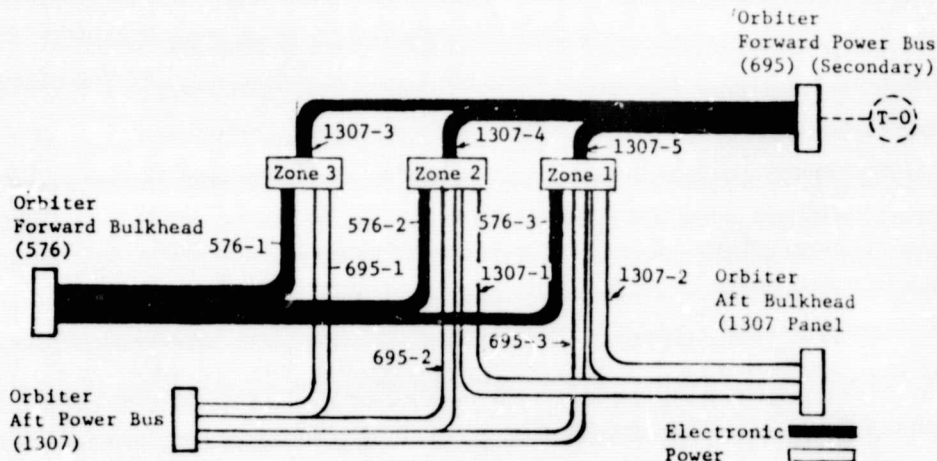
J. Heberlig, NASA/JSC

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Automated Payload/Orbiter Cabling 330-03-09-01

2. EQUIPMENT DESCRIPTION:

A concept for interfacing automated payloads with the orbiter is shown in the figure. One cable set would consist of the 11 cables shown on the figure. These cables would be installed/removed as required to minimize weight penalties associated with common cabling. Power leads would be separated from signal leads. One cable set would be required for each orbiter plus one spare.



3. PHYSICAL CHARACTERISTICS:

Cable Set Components	Signals/Power				Equivalent Length, ft	Weight, lb
	TSP	TS5C	TP	COAX		
576-1	36	3	0	8	65	102
-2	32	1	0	8	45	60
-3	24	1	0	4	25	22
695-1	0	0	2	0	57	2
-2	0	0	2	0	37	2
-3	0	0	2	0	17	1
1307-1	0	0	2	0	17	1
-2	0	0	2	0	37	2
-3	24	1	0	0	65	57
-4	32	1	0	0	45	60
-5	36	3	0	0	25	33

Automated Payload/Orbiter Cabling 330-03-09-01 (Cont'd)

4. PURPOSE AND INTENDED APPLICATION:

a. Function and Capability:

Payloads require cabling to interface them with the orbiter for orbiter provided electrical services. See sketch and table of physical characteristics above.

b. What Types of Payloads:

Automated deployed by the orbiter

c. What STS Elements are Involved:

Orbiter

d. Describe Interface Requirements:

The orbiter provides standard electrical interfaces for payloads at stations X_O 576, 695, and 1307. Station X_O 576 is the primary electrical interface for orbiter services. Payload interfaces with the orbiter data, communication, MSS, PSS, C&D, timing, C&W, etc., are accomplished via this panel. Current wiring interfaces provided at this panel include: 228 twisted-shielded-pair (TSP), 90 twisted pair (TP), 29 twisted-shielded-five-conductor (TS5C), and 18 coax connectors. Station X_O 695 is the primary power interface for payloads. In addition, secondary power is also available on the right hand sidewall. Station X_O 1307 provides two separate power interfaces for payloads and also provides standard panels for interfacing with the T-O ground umbilical.

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

HE-24-A, ST-01-A, October 1979

6. IDENTIFY ALL POTENTIAL USERS:

All NASA and Civil payloads delivered by the orbiter without upper stages. (Reference a and b) DoD, DMSP payload (Reference g)

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

49 NASA payloads through 1991

1 DoD payload, flight rate TBD

Automated Payload/Orbiter Cabling 330-03-09-01 (Cont'd)

8. EQUIPMENT COST ESTIMATE:

Non-Recurring - \$41,000

Recurring - \$344,000

Development Schedule - Start design April 1977; Deliver January 1979

9. POTENTIAL VALUE OF EQUIPMENT:

Savings of approximately 67% when compared to payload-unique cabling.

10. STATUS:

Not currently funded

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. MCR-76-202, Catalog MMSE, MMC, June 1976
- b. MCR-76-202, Volume II, Book 1, Final Report MMSE, Requirements, Definition, and Design Analysis, MMC, June 1976
- c. MCR-76-202, Volume III, Final Report MMSE, Project Cost Estimates, MMC, June 1976
- d. ATR-76(7362)-1, Volume III: Ancillary Equipment Study, STS Users Study (Study 2.2) Final Report, Aerospace, November 1975
- e. SAMSO-TR-76-103, DoD Space Transportation System Payload Interface Support Study Final Report, MDAC, December 1976
- f. SAMSO-TR-76-212, Volume II, DoD Shuttle Integration Support Study Final Report, Rockwell International, November 1976
- g. DoD Shuttle Integration Support Study Final Briefing, 12th Technical Review, 8 December 1976, Rockwell International F04701-75-C-0184)

12. CONTACT

J. Heberlig, NASA/JSC

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Contamination Monitoring

2. EQUIPMENT DESCRIPTION:

Includes:

- Induced Environment Contamination Monitor (IECM)
- Trace Gas Analyzer

3. PHYSICAL CHARACTERISTICS:

See individual items

4. PURPOSE AND INTENDED APPLICATION:

a. Function and Capability:

To provide the capability for monitoring, contaminants and gases in the orbiter payload bay

b. What Types of Payloads:

Automated, Automated with IUS, Spacelab

c. What STS Elements are Involved:

Orbiter

d. Describe Interface Requirements:

Shuttle Power and Distribution

Payload Specialist Station

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

OFT #1 1979

6. IDENTIFY ALL POTENTIAL USERS:

All NASA, DoD, and civil payloads concerned with contamination

7. ESTIMATE FLIGHT RATE **OR** NUMBER REQUIRED:

First six flights; flight 7 and following by request of STS users (usually first flights of contamination sensitive payloads)

8. EQUIPMENT COST ESTIMATE:

See individual item

9. POTENTIAL VALUE OF EQUIPMENT:

Concerned payloads would provide contamination protection

10. STATUS:

See individual item

11. REFERENCE(S) FOR ADDITIONAL DATA:

See individual item

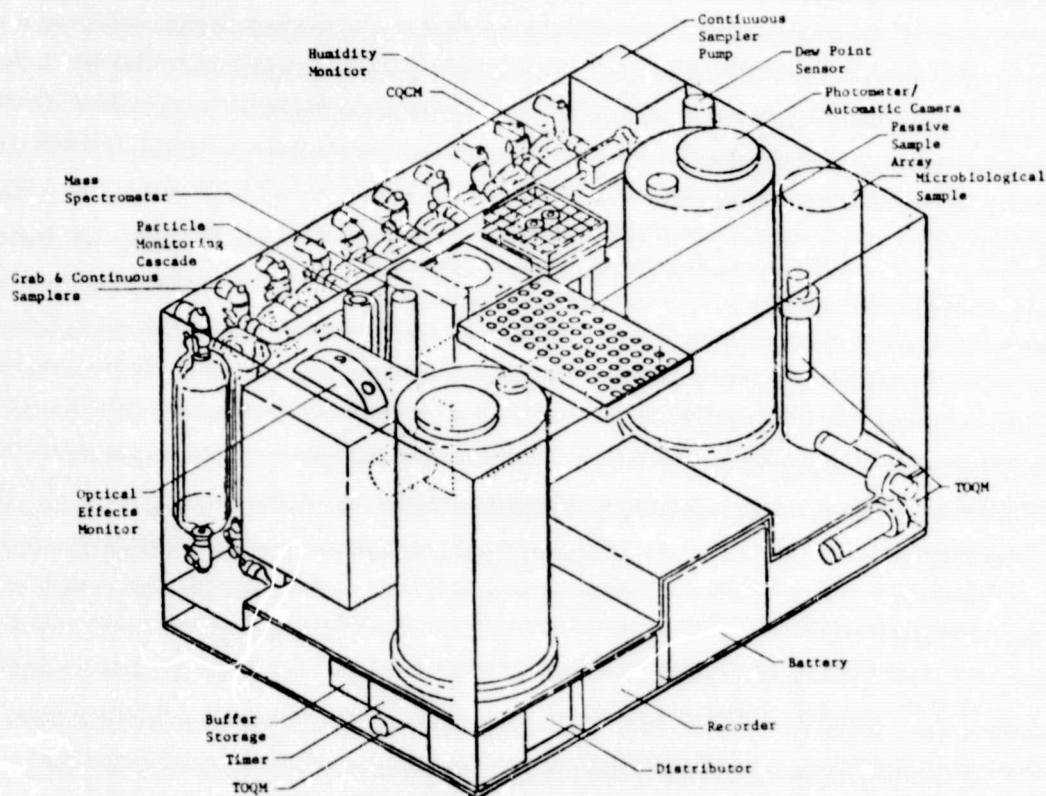
1. NAME OF ITEM AND IDENTIFYING NUMBER:

Induced Environment Contamination Monitor (IECM) - No. TBD

2. EQUIPMENT DESCRIPTION: (See Figure 1)

Includes:

- Mass Spectrometer
- Optical Effects Monitor
- Grab and Continuous Samplers
- Particle Monitoring Cascade
- Humidity Monitor
- Photometer/Camera
- Passive Sample Array
- Microbiological Sampler



3. PHYSICAL CHARACTERISTICS:

- (a) Size: 49.0 x 33.25 x 30 in.
- (b) Weight: 750 lb

4. PURPOSE AND INTENDED APPLICATION:

(a) Function and Capability:

Will conduct an in-depth survey of the potential contamination of experiments and other payloads from the induced environment in and around the STS during launch, deployment, retrieval, and landing. This package will be used for the following:

- (1) Verify the contamination requirements specified in paragraphs 3.6.12.4.1 through 3.6.12.4.6, Vol. X, JSC 07700.
- (2) Provide diagnostic data to identify any sources that contribute to out-of-specification conditions so that corrective action can be taken.
- (3) Measure the contamination effects from delivery, deployment, retrieval, and landing a free-flying payload.
- (4) Perform routine monitoring to detect any anomalous operating conditions such as leaks in the hydraulic, coolant, or fuel system; sloughing off particulates from TPS, insulation, or experiments; outgassing from new components or various experiments.

The specific measurements to be made in the payload bay during times when there is a sensible atmosphere in the payload bay including ascent and descent are:

- (1) Measure aerosol count and size distribution for particles 0.3 micron and larger at concentration levels corresponding to Class 100.
- (2) Measure deposition of non-volatile residue with a detection threshold of 0.1 microgram/cm².
- (3) Measurement of dust fall with a detection threshold equivalent to a Class 300 cleanliness level.
- (4) Detection and identification of trace quantities by hydrocarbons, phthalate esters, silicones, NH₃, HCl, NO_x, NH₄, OH, HNO_x, and other possible contaminants at concentrations of a few ppm.

- (5) H₂O vapor concentration and dew point measurement.
- (6) Air temperature measurement
- (7) Total pressure measurement from atmospheric to 10^{-3} Torr.

Specific measurements to be made during orbital operations are:

- (1) Map the directional fluxes of condensible molecules in the cargo bay as a function of time at levels of 10^{-10} grams/cm²/sec with 1 min resolution and detect long term changes smaller than 10^{-8} gm/cm².
 - (2) Measure the heats of absorption and evaporation rates of the above molecules.
 - (3) Assess the optical damage produced by the above molecules by continuously monitoring the transmission and hemispherical scattering of an optical surface with a detection threshold of a 1% change. A more detailed analysis of the deposited material and its optical properties will be performed post-flight on the recovered samples.
 - (4) Measure the condensation rate of returning H₂O molecules on a cryogenic surface at level of 10^{12} molecules/cm²/sec.
 - (5) Measure the column density of various species in the spacecraft induced atmosphere with a detection capability of 10^{10} - 10^{-2} molecules/cm².
 - (6) Determine the number of dust particles larger than 5 microns in the vicinity of the spacecraft; measure their size, positions, and velocities; and determine their origin.
 - (7) Determine the background brightness from unresolved particles and molecules at background levels of 6×10^{-15} solar brightnesses.
- (b) What Types of Payloads:
Automated, automated with the IUS and Spacelab.
- (c) What STS Elements are Involved:
Orbiter, Spacelab, and IUS
- (d) Describe Interface Requirements:
Shuttle Power and Distribution
Special Purpose GSE as Required
Compatible with RMS for Positioning

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

First Orbital Flight Test (OFT) in mid-1979.
6. IDENTIFY ALL POTENTIAL USERS:

1979-1981 All (OFT payloads, LDEF, Spacelab)
1982-1991 New payload configurations and by request for NASA and DoD payloads concerned with contamination
7. ESTIMATE FLIGHT RATE:

1979-1981 All
1982-1991 TBD
8. EQUIPMENT COST ESTIMATE:

Non-Recurring	}	Approximately \$3.8 Million
Recurring		

Development Schedule - Begin design in Fiscal Year 1977
9. POTENTIAL VALUE OF EQUIPMENT:

Contamination protection provided by concerned payloads
10. STATUS:

First two units and spares are under development
11. REFERENCE(S) FOR ADDITIONAL DATA:
 - a. MMC Contamination Study
 - b. Draft of IECM Report Provided by NASA (H. Gangl) 8 April 1976
 - c. Project Plan, IECM for OFT 1-6 and LDEF, MSFC, October 1976
12. CONTACT:

G. M. Arnett - NASA/MSFC

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Trace Gas Analyzer - Number TBD

2. EQUIPMENT DESCRIPTION:

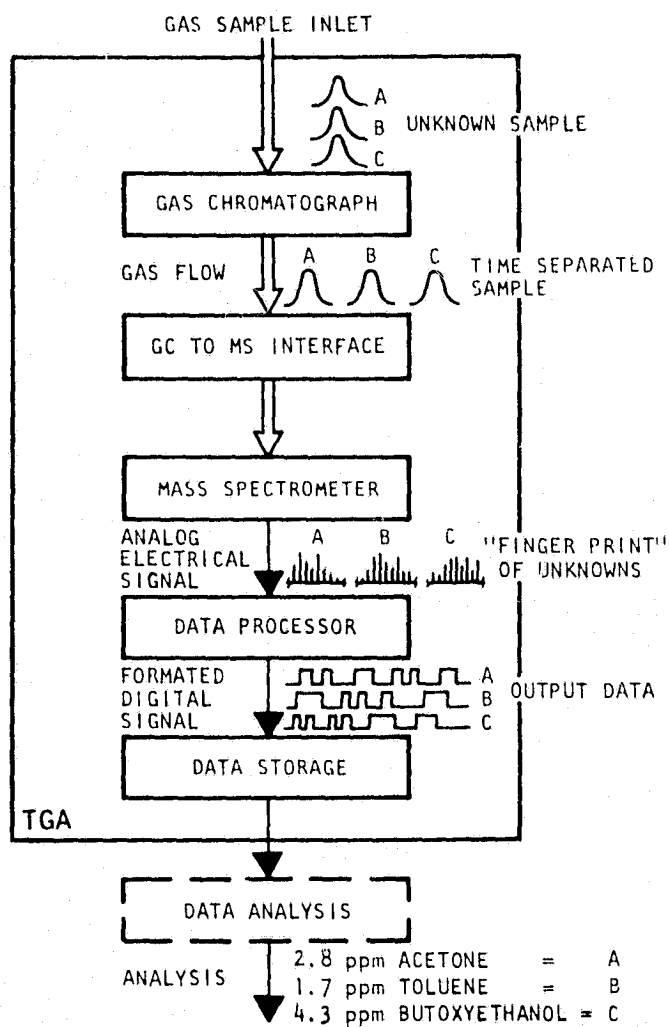
The Trace Gas Analyzer is a fully automated analytical instrument specifically designed for pre-flight and in-flight monitoring of off gassing products from payload materials and other sources onboard the STS/Spacelab.

The potentially complex nature of the Space Shuttle/Spacelab atmospheric impurity monitoring problem demands a proven approach for the Trace Gas Analyzer with capability for analyzing gas mixtures for all types of trace level compounds. The gas chromatograph/mass spectrometer (or GCMS) is the only instrument capable of performing this task.

A gas chromatograph/mass spectrometer (GCMS) is an analytical instrument combining two distinctly different devices to achieve superior ability for mixture analysis. A gas chromatograph is utilized to separate complex mixtures into their constituent parts by the ingenious but simple application of fundamental processes of physical chemistry. Although the gas chromatograph is well suited for separation, it does not generate sufficient information for positive identification of compounds in an unknown sample.

A mass spectrometer, on the other hand, is well suited for compound identification because it obtains detailed data on molecular structure that are fundamental and unique to each species. It cannot perform this function directly on complex mixtures because interferences lead to uninterpretable results. When these tools are combined in tandem with an appropriate interface they form a powerful instrument for qualitative and quantitative mixture analysis.

The output information from the Trace Gas Analyzer is a sequential series of "finger points" of the detected compounds. These "finger points" are rapidly screened by a small computer against a library of "finger points" of suspected compounds. A match or fit between an unknown and one of the suspects constitutes an identification of the unknown.



GCMS SYSTEM DIAGRAM

3. PHYSICAL CHARACTERISTICS:

- (a) Size: Less than 2.5 ft³
- (b) Weight: Less than 85 lb

4. PURPOSE AND INTENDED APPLICATION:

- (a) Capability and Function:

The gas chromatograph/mass spectrometer (GCMS) samples a small amount of the atmosphere, separates the sample into its component parts, and then sequentially characterizes and quantifies these individual constituents. This is accomplished in a way that utilizes very general chemical properties so that it is applicable to virtually any potential compound.

The output data from the Trace Gas Analyzer (TGA) is analyzed by rapid computer search methods to identify the detected compounds. The measured levels of these compounds are compared to their maximum allowed concentrations to determine if a potentially hazardous condition exists.

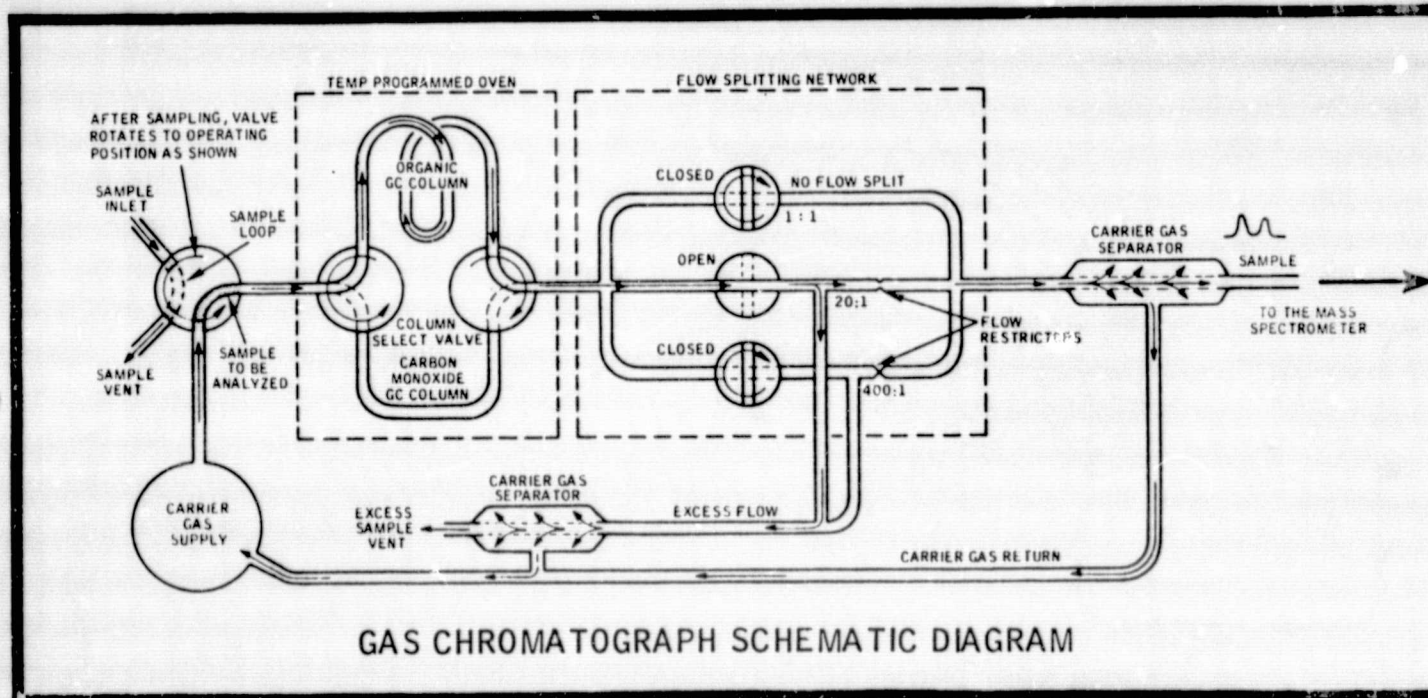
The TGA's sensitivity is high enough to allow trends in the levels of most impurities to be followed before they reach a point of concern. This provides early warning for implementing preventative and/or corrective measures.

Gas Chromatograph Operation

The individual constituents of a gaseous mixture are separated in a gas chromatograph by injecting the sample into one end of a specially prepared tubular column packed or coated with a sorbent material. The sample is driven through the column by the flow of a carrier gas. The unique interaction of each constituent with the sorbent and carrier determines the time required for the sample to traverse the column. With this technique, gas chromatographs can be designed to separate the components in a wide variety of complex mixtures.

The TGA breadboard presently employs two gas chromatograph columns; a short packed column using a molecular sieve to isolate carbon monoxide; and a long capillary column to separate the other constituents.

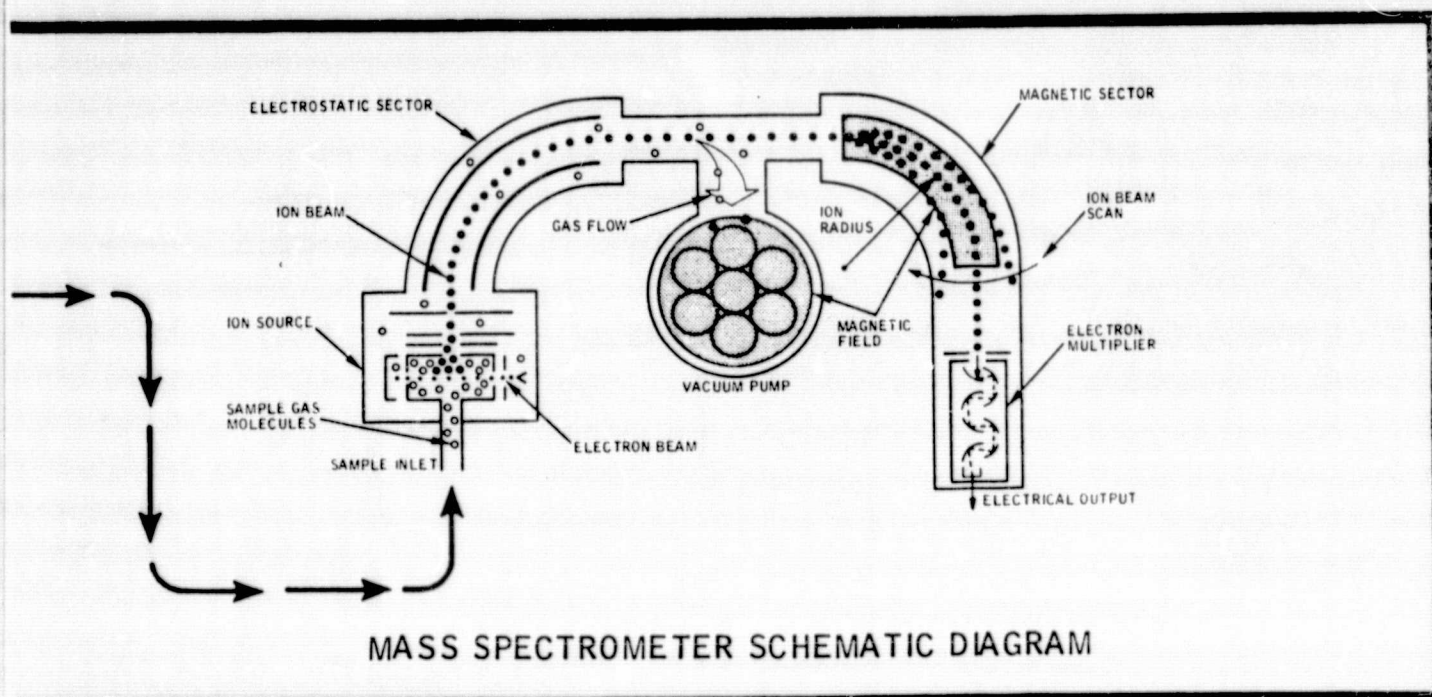
In this application, the gas chromatograph effluent passes through a flow splitting network, actuated by the MS to maintain the sample level "on scale." The selected portion of the sample passes through a unique and highly efficient carrier gas separator. Its essential element, a silver/palladium alloy capillary line, allows the carrier gas to diffuse through thin tubular walls leaving the separated sample pulses to continue to the MS. The carrier gas is returned to the carrier gas supply for reuse, minimizing the quantity of carrier gas required.



Mass Spectrometer Operation

A mass spectrometer (MS) is a device for determining the mass or molecular weight of a substance. Specifically, it ascertains the mass-to-charge ratio (m/e) of gaseous ions derived from the sample. These ions are created in an ion source by electron bombardment. The resulting ions are focused in a narrow beam by electrostatic forces and directed to the analyzer. This device separates the ions by magnetic forces sending them in circular orbits with radii determined by their m/e ratios. The resolved ion beams are sequentially scanned past a resolving slit bringing them to an electron multiplier. Here they are converted to an amplified electronic signal, forming a series of peaks called a mass spectrum.

When molecules are ionized in the MS, they are also broken apart or fragmented at the various atomic bonds. The distribution of bond cleavages depends upon the precise nature of the molecular structure. Thus, multiple ion fragments with different abundances at each m/e ratio are created from a single compound. The intensity of the mass spectrum is proportional to the abundance of the compound, while the unique fragmentation pattern gives positive identification. The fragmentation pattern is the structural "finger point" of the compound.



TGA Data Processing

The TGA data system combines a microprocessor with high speed, hardwired electronics to process the analog MS output data at an average rate of up to 100 mass peaks per second. Its operations include filtering, mass peak detection, mass marking, A to D and log/linear conversions, formatting, and buffering to tape storage. The stored data includes a complete mass spectra for all peaks above a threshold level, identified by integer mass numbers, and housekeeping data including a gas chromatograph elution time mark that is recorded at the beginning of each mass spectrum. This data is analyzed to identify the compounds that have been characterized by the GCMS.

TGA Data Analysis

The analysis of the TGA output data is carried out by a fast computer search technique that compares the unknown mass spectra against a library of known spectra. The library of 500 or so compounds is composed of potential atmospheric impurities selected for their toxicity and probability of occurrence. This data, developed from existing information and materials screening tests for Spacelab hardware, should cover most occurrences thereby allowing a fully automatic, on-line analysis in most situations.

The library search technique is streamlined by two factors. First, each library spectrum is highly simplified, a "reduced spectrum" containing in most cases only five mass peaks that most uniquely define the compound. When the spectrum of an unknown compound is compared to a library spectrum, only those peaks in its spectrum corresponding to the mass numbers in the "reduced spectrum" of the library compound are used.

The second short cut limits the number of library spectra compared against a given unknown to those with gas chromatograph retention times corresponding to the time in the analysis cycle where the unknown appeared. In this way only a small part of the library needs to be searched for each compound identification. A fit or match is indicated when the ratios of selected pairs of mass peaks agree with those for a library spectrum within prescribed tolerances.

In the relatively unlikely event that an unknown remains unidentified after the fast search, its spectrum can be subjected to off-line analysis by existing computer search programs using a library of over 20,000 known mass spectra.

The levels of the identified compounds are compared to specified maximum allowable concentrations for each constituent. These MACs are based upon toxicological concentration limits for a given exposure period. A compound with a level exceeding its specified short term MAC would be flagged for corrective or preventive measures. A compound with a lower level would be subjected to a trend analysis to establish its rate of increase in concentration and its accumulated effects over the course of the mission. These procedures will be automated to provide the capability for rapid decision making.

TGA Specifications

Compounds - All types of organic and inorganic compounds including carbon monoxide.

Detectable Limit - Less than 1 part per million (ppm) for most compounds.

Dynamic Range - Nominally 0.5 to 500 ppm, depends on specific compound.

Accuracy - Better than ± 20 percent at the 1 ppm level.

Analysis Time - 90 minutes, maximum.

Mixture Capability - 100 to 200 compounds may coexist without appreciable performance degradation.

Power - Approximately 140 watts average.

(b) What Types of Payloads:

Automated, automated with IUS, Spacelab

(c) What STS Elements Are Involved:

Orbiter, Spacelab

(d) Describe Interface Requirements:

Power
Data Output
Standard Rack Mounting

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

Available for OFT #5 - 1980

6. IDENTIFY ALL POTENTIAL USERS:

Primarily Spacelab; potentially all payloads

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

1979-1981: Recommended for all missions (when available)

1982-1991: It will be required on all missions that have equipment within the pressurized volume of the Shuttle that are not designed to the full material requirements of the Shuttle program.

8. EQUIPMENT COST ESTIMATE:

Non-Recurring - TBD

Recurring - TBD

Development Schedule - RFP mid 1977; available for OFT #5
early 1980

9. POTENTIAL VALUE OF EQUIPMENT:

The alternative to a flight Trace Gas Sensor, capable of identifying low level toxic constituents, would be to require all materials within the pressurized volume of the Shuttle to be controlled and tested to the full regime of materials requirements. Application of all material requirements to payload hardware would be a significant increase in cost to all payloads requiring equipment in the pressurized volume.

10. STATUS:

Study completed 31 December 1976. RTOP written.

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. Trace Gas Analyzer, Brochure, Perkin-Elmer and Beckman Instruments, No Date.

12. CONTACT:

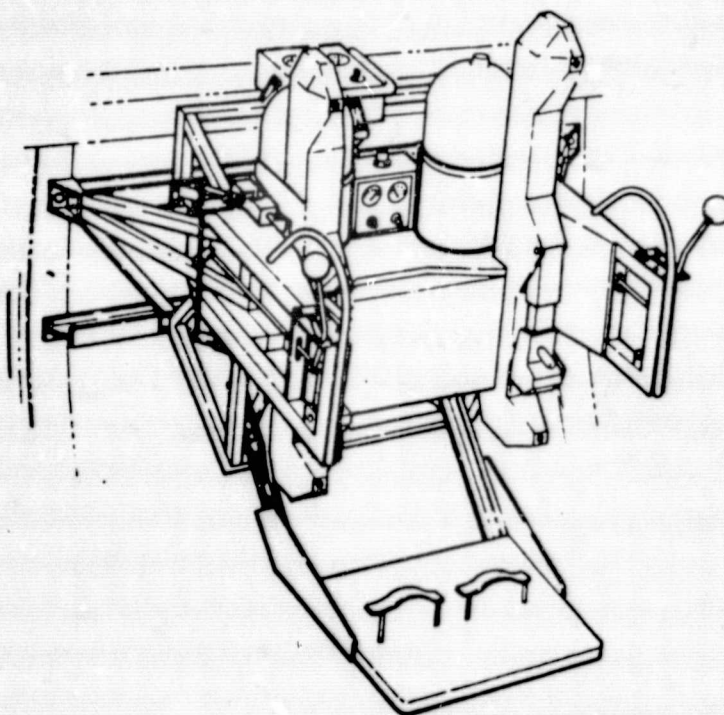
J. D. Denais - NASA/JSC

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Manned Maneuvering Unit (MMU) - No. TBD

2. EQUIPMENT DESCRIPTION:

The MMU is a modular device that can be readily attached to the EVA crewman to provide him with an autonomous maneuvering capability in the vicinity of the Shuttle Orbiter. The MMU, which uses cold gas propellant, will have sufficient system redundancy to allow safe return of the crewman to the Orbiter in the event of a single MMU system failure. The MMU hardware consists of the MMU and a flight support station located in the payload bay to hold the MMU for launch/reentry, donning/doffing, and servicing.



MMU STOWED IN
FLIGHT SUPPORT STATION (FSS)

3. PHYSICAL CHARACTERISTICS:

- a. Size:
- b. Weight: MMU - 225 lbs, FSS - 50 lbs.

4. PURPOSE AND INTENDED APPLICATION:

- a. Capability and Function:

The MMU enables an astronaut to maneuver while in free flight in the vicinity of the orbiter. The manned maneuvering unit (MMU) is intended primarily to support orbital flight test of the shuttle but is available during the operational phase of the program if required to support payload operations. The MMU will support extra-vehicular manned operation in the immediate vicinity of the orbiter for the purpose of planned or contingency payload retrieval, maneuvering, cleaning, film exchange, data retrieval, fly-around inspection, and possible inflight repair of payloads. Stowage attachment provisions will be provided for all missions. Weight and volume for the MMU flown in support of payloads is chargeable to payloads.

MMU uses non-contamination gaseous nitrogen to provide 66 ft/sec per charge and is rechargeable on orbit. MMU has manual rotational control with automatic attitude hold. Two 28 VDC 2 AMP utility outlets and mounting brackets are available for ancillary equipment (cameras, lights, tools etc.)

- b. What Types of Payloads:

Automated, Spacelab

- c. What STS Elements are Involved:

Orbiter, Spacelab

- d. Describe Interface Requirements:

Payload bridge fitting bolt holes in orbiter used to attach FSS.

Requires GN₂ supply for recharge

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

TBD (Available June 1981)

6. IDENTIFY ALL POTENTIAL USERS:

Any payload could make use of the MMU. Actual users TBD.

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

TBD

8. EQUIPMENT COST ESTIMATE:

Non-Recurring - TBD

Recurring - TBD

Development Schedule - Available for flight Sept. 1, 1981

9. POTENTIAL VALUE OF EQUIPMENT:

None known

10. STATUS:

MMU design definition R TOP contract awarded to MMC April 1975. Final report due 1 Feb 1977.

11. REFERENCE(S) FOR ADDITIONAL DATA:

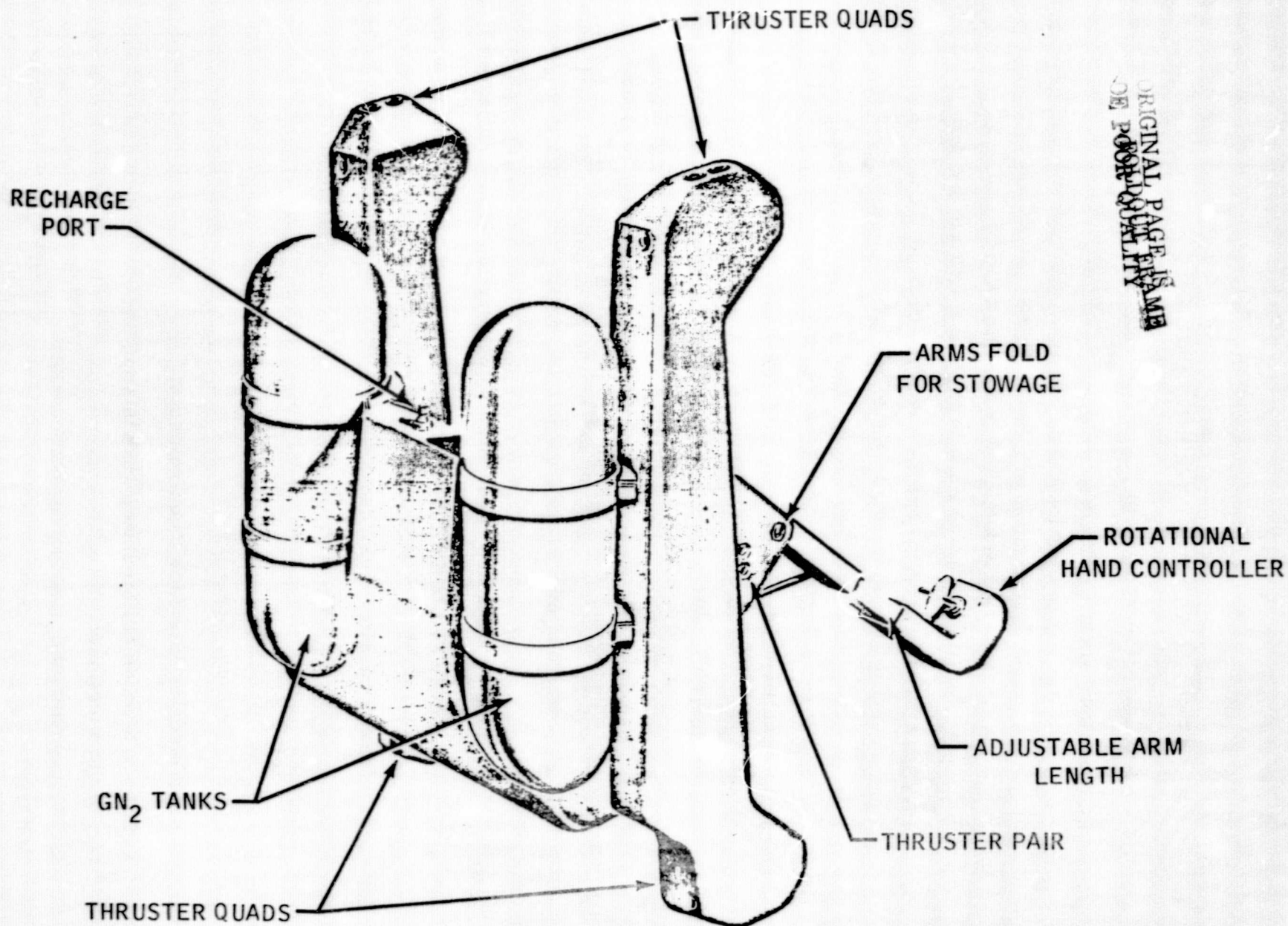
a. NASA-5-76-3835 Space Shuttle Manned Maneuvering Unit Program Review. JSC Sept. 1976.

b. MCR-75-229 Catalog MMSE, MMC June 1975

12. CONTACT:

TBD

MMU FEATURES



ORIGINAL PAGE IS
OF POOR QUALITY

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Auxiliary Power System

2. EQUIPMENT DESCRIPTION:

Includes:

- Auxiliary Payload Power System (APPS) or
- Multi-Discipline Auxiliary Payload Power System (MAPPS)

3. PHYSICAL CHARACTERISTICS:

See individual item

4. PURPOSE AND INTENDED APPLICATION:

a. Capability and Function:

Review of SSPD payload requirements indicates that the auxiliary power is required for supplemental average and peak power and for supplemental energy. The major requirement is for space processing where 12 of 16 payloads exceed Spacelab capabilities. In addition, three additional SSPD payloads require supplemental average power (AP-06-S, EO-11-S and EO-20-S); and one payload (AP-06-S) requires additional peak power and energy.

Review of eight Spacelab missions planned for early Shuttle Flights indicates three flights (Flights 12, 19 and 25) exceed Spacelab average power available; and flight 19 exceeds energy available. This auxiliary payload power system would supply the required power and energy.

b. What Types of Payloads:

Spacelab, also Potentially on Multiple Automated

c. What STS Elements are Involved:

Orbiter, Spacelab

d. Describe Interface Requirements:

Mechanical Mounting Provisions

Electrical

Thermal

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

Spacelab Early 1981
6. IDENTIFY ALL POTENTIAL USERS:

Space processing missions, AP-06-S, EO-11-S and EO-20-S, as well as some multiple automated payload missions.
7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

1979-1981 Approx 4 to 6 uses
1982-1991 TBD
8. EQUIPMENT COST ESTIMATE:

See individual items
9. POTENTIAL VALUE OF EQUIPMENT:

Payloads requiring power and thermal provisions exceeding the orbiter and spacelab capabilities would provide their own.
10. STATUS:

Studies have been made. Not to be funded in FY 78 or FY 79
11. REFERENCE(S) FOR ADDITIONAL DATA:

See individual item
12. CONTACT:

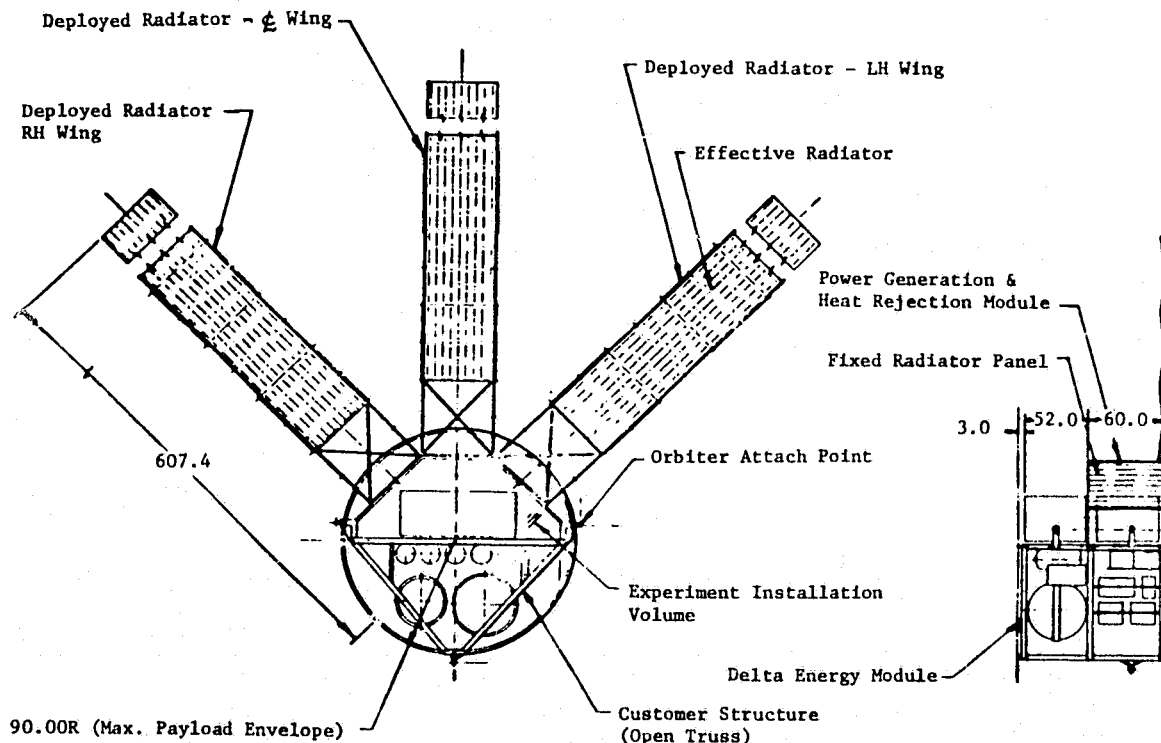
J. Bredt NASA/Headquarters
J. Poe NASA/MSFC

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Auxiliary Payload Power System, No. TBD

2. EQUIPMENT DESCRIPTION:

The APPS is an autonomous system that includes fuel cells, storage devices, conditioning equipment, distribution system and radiator area. The system will generate, store, condition and distribute power and will collect and dissipate heat. The APPS was originally intended for use with Space Processing payloads only. The APPS would be used to provide supplemental power to Space Processing payloads, SSPD payloads with high power requirements, and multiple payloads that might fly on one mission.



3. PHYSICAL DESCRIPTION:

- a. Size: 10 ft. length
- b. Weight: 7748 lbs.

4. PURPOSE AND INTENDED APPLICATION:

a. Capability and Function:

Basic design philosophy is use of ATM-type deployable radiator and selection of Shuttle derived hardware to minimize DDT&E costs. The APPS comprises two modules. The primary module is a 5 ft (1.5 m) long Power Generation and Heat Rejection Module containing the subsystems for electrical power, thermal control, and communications and data handling plus a 6.2 m^3 (218 ft^3) installation volume for Space Processing Applications (SPA) experiments. The secondary module is a 1.22 m (4 ft) long Delta energy kit and contains the additional fuel cell cryogen and product water storage tanks necessary to provide an additional 966 kWh of electrical energy for a total of 1932 kWh. The secondary module also provides an additional 12.4 m^3 (438 ft^3) installation volume for SPA experiments.

The APPS structure is open truss modular construction. The basic structure weight 375 kg (830 lb); APPS subsystems weight 3150 kg (6918 lb); and 900 kg (1983 lb) is available for experiment equipment.

The electrical subsystem consists of Shuttle-type fuel cells, reactant tanks, product water storage tanks, and inverters, plus silver-zinc batteries, and battery chargers. The recommended baseline system is capable of providing 1932 kWh of energy at a sustained power level of 14 kW. This capability requires two fuel cells, two reactant tank sets, and 10 product water tanks. The recommended baseline can be readily modified by removal of reactant and product water tanks or one of the two fuel cells for missions having lower energy or power requirements.

The recommended thermal control subsystem incorporates a separate SPA low temperature experiments coolant loop which interfaces with dual redundant APPS equipment/radiator coolant loops through a Shuttle fuel cell-type heat exchanger. Shuttle-type components are used for the radiator-panel construction, control valves, pump packages, coolant fluid, heat exchangers, and instrumentation.

The coolant loop and 104 m^2 (1082 ft^2) of effective radiator area can reject power and waste heat associated with up to 19.8 kW of fuel cell power generation. The deployable radiators are adaptable to modularity and one or more of the three panel assembly wings can be removed before flight.

- b. What Types of Payloads:
 Spacelab, Potentially on Multiple Automated
- c. What STS Elements are Involved:
 Orbiter, Spacelab
- d. Describe Interface Requirements:
 Mechanical Mounting Provisions
 Electrical
 Thermal
- 5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:
 TBD
- 6. IDENTIFY ALL POTENTIAL USERS:
 Space Processing Missions, AD-06-S, EO-11-S, EO-20-S
 as Well as Multiple Automated Payloads (See Reference b)
- 7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:
 1979-1981 Approx 4 to 6 Uses
 1982-1991 TBD
- 8. EQUIPMENT COST ESTIMATE:
 Non-Recurring - TBD
 Recurring - TBD
 Development Schedule - TBD
- 9. POTENTIAL VALUE OF EQUIPMENT:
 Payloads requiring power and thermal provisions exceeding
 spacelab capabilities would provide their own.
- 10. STATUS:
 Not to be funded in FY 78 or FY 79
- 11. REFERENCE(S) FOR ADDITIONAL DATA:
 - a. Auxiliary Payload Power System Study, Task Report I, II, III
 and IV NASA/MSFC Contract NAS 8-31361 MDAC-E, 1975.
 - b. MCR-76-202, MMC MMSE Final Report, Vol II, Book 1,
 Requirements, Definition, and Design Analysis, June 1976
- 12. CONTACT:
 J. Bredt NASA/Headquarters
 J. Poe NASA/MSFC

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Multi-Discipline Auxiliary Payload Power System, No. TBD

2. EQUIPMENT DESCRIPTION:

It was found (see Figure 1) that one or two extra fuel cells (as required) could be located intruding to a minor degree into the payload bay very close to the present location of the three Orbiter fuel cells. The cryogenics supply for these cells is the standard Orbiter extended mission kit tankage supply which can utilize up to 5 sets of tanks. Since these are already part of the Orbiter program, no expense for tankage development nor procurement is necessary. The radiator panels needed to reject the electric power heat (see Figure 2) are standard Orbiter radiator panels and thus require no new development. The entire system is flexible for any payload requirement. A prime virtue is that very little of the Orbiter payload bay volume is taken up by the power kit, and no special pallet or support module is required for radiator support; radiators can be bolted to the top of any convenient Spacelab pallet to be utilized in the same mission.

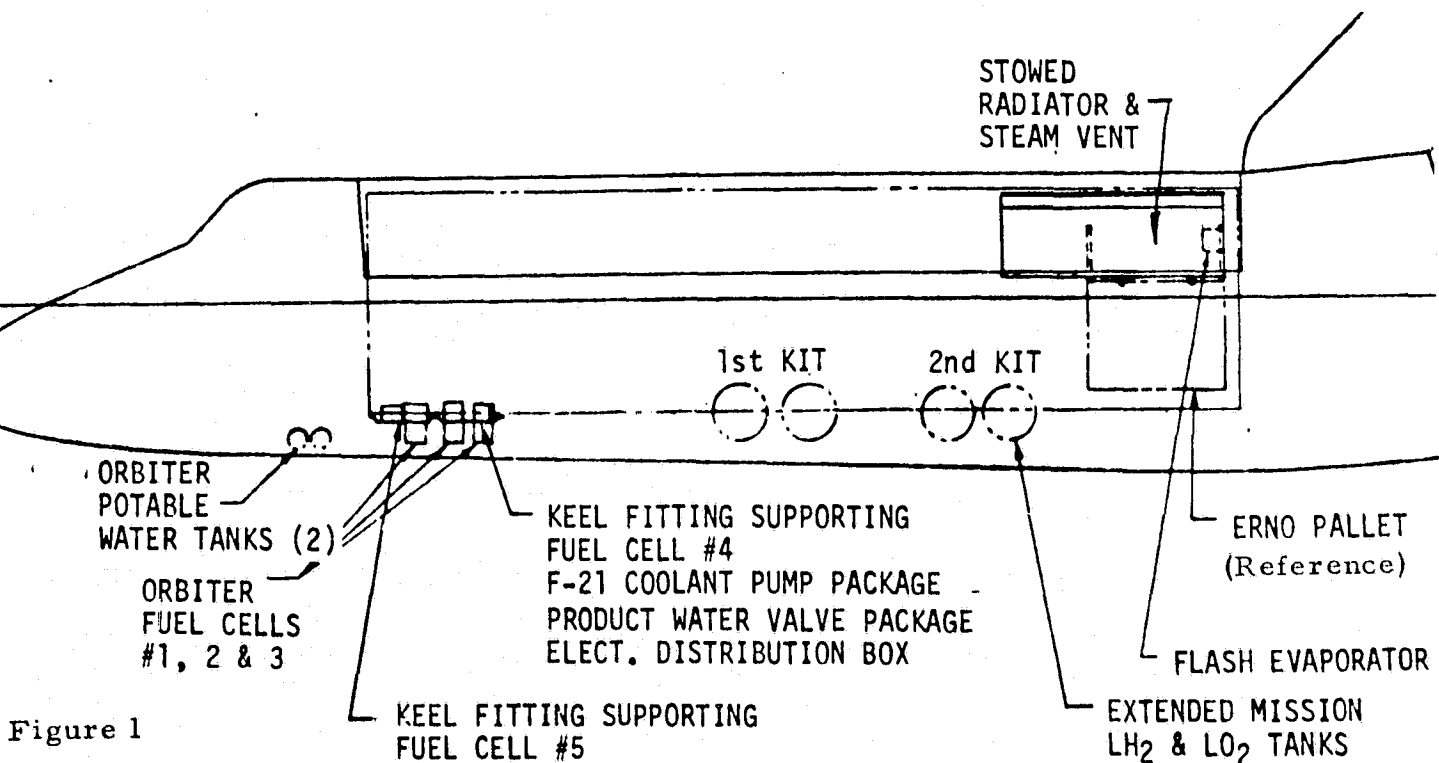


Figure 1

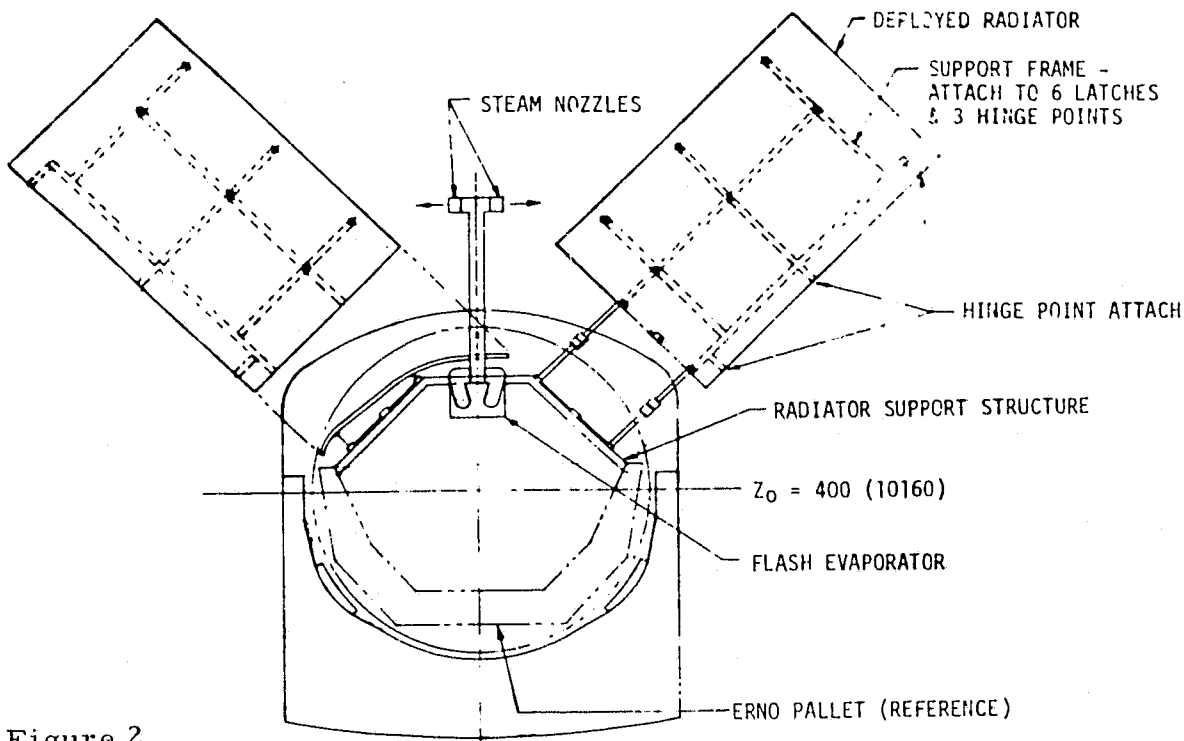


Figure 2

3. PHYSICAL CHARACTERISTICS:

- a. Size: Radiator Stowed, About 15 Ft. Long x 30 In. Deep
- b. Weight: 4327 Lbs.

4. PURPOSE AND INTENDED APPLICATION:

- a. Capability and Function:

Payload power requirements, from the 1975 SSPD exceed the 7.0 kw available from the Orbiter as specified in JSC 07700, Vol. XIV. Some specific payload requirements include the space processing payloads requiring average power ranging from 3.5 to 13.6 kw with peaks to 22.0 kw for 18 minutes, an imaging radar payload requiring 5.0 kw and the AMPS payload requiring 5.8 kw. In addition, many Shuttle flights will involve grouped payloads to utilize full carrying capacity. An example of the effect of grouping payloads can be found in the MOSC study where 3 of 18 grouped payloads required average power of 8.0, 15.4, and 16.4 kw.

Another factor to be considered in sortie missions is the Spacelab subsystem requirements for 1.8 - 3.0 kw which reduces the net power available for experiments to 4.0 - 5.2 kw; not the total 7 kw.

Comparison of high payload power requirements with Orbiter capabilities reveals a power deficiency that must be made up if the indicated individual payloads are to fly and if the full Shuttle payload carrying capacity is to be utilized.

The generation and use of power above Orbiter capability requires the addition of a heat rejection system. It is required to dissipate the heat produced during the inefficient operation of the fuel cells and that resulting from the use of the electrical power.

The heat rejection is independent of the Orbiter systems but utilize Orbiter designed hardware such as the radiator panels which are identical to the current forward two-sided panels.

The radiator installation (see Figure 2) shows the location of the flash evaporator non-propulsive steam vent nozzles in their deployed position. Their location at the rear of the radiator panels and the payload bay, along with the side facing nozzles should present no contamination problem to the payloads.

b. What Types of Payloads:

Spacelab, Multiple Automated

c. What STS Elements are Involved:

Orbiter, Spacelab

d. Describe Interface Requirements:

Mechanical Mounting

Electrical Cabling

Fluid for Cooling

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

Spacelab Early 1981

6. IDENTIFY ALL POTENTIAL USERS:

Space Processing (SP-01, 02, 03, 04, 14, 15-S) EO-20-S, AP-06-S
Also Multiple Automated Payloads with High Power Requirements

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

At Least 90 Missions Identified

8. EQUIPMENT COST ESTIMATE:

Non-recurring -

First Unit \$3.7 Million

Recurring -

Development Schedule - Start Phase AB January 77 Deliver
Mid 1980

9. POTENTIAL VALUE OF EQUIPMENT:

Additional power must be provided by the user programs

10. STATUS:

Not planned for funding in FY 78 or FY 79

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. SD 75-SA-0182, Use Of STS Equipment (Subsystems/Components)
For MMSE, Contract NASA-14598, Final Briefing 10 December 1975,
Rockwell International
- b. SD 75-SA-0181, Use Of STS Subsystems and Components For
MMSE, Executive Summary, Vol 1; Dec 1975, Rockwell International

12. CONTACT:

TBD

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Payload Specialist Station - No. TBD

2. EQUIPMENT DESCRIPTION:

The STS provides some limited equipment for control and monitor of payload operations from the aft flight deck (AFD). In addition, space is provided to locate payload C&D equipment. Figures 1 and 2 show these payload related areas. A study has been published (reference a) which configures a concept for utilization of the payload space, allowing one equipment configuration to satisfy over 90 percent of the known payload C&D requirements. This core concept defines use of Spacelab equipment (CRT/keyboard, RAU, and power distribution box) and two approaches for implementation of multifunction display system (MFDS) requirements. The two approaches are reflected in figures 3 and 4.

3. PHYSICAL CHARACTERISTICS:

- a. Size: The core C&D panels all mount within the standard 19-inch racks provided by the Orbiter. Four of the panels (L10, L11, L12, and R12) occupy a full rack module (19 inches wide x 21 inches high x 20 inches deep), and the on-orbit station rack (A7) occupies a smaller volume (19 inches wide x 14 inches high x 8.0 to 9.5 inches deep). The volume behind the panel surfaces houses electronics associated with the C&D (e.g., display electronics, experiment RAU, etc.).
- b. Weight: Approximately 250 pounds for the STS equipment configuration.

4. PURPOSE AND INTENDED APPLICATION:

a. Function and Capability:

The multifunction display system (MFDS) is located at the Payload Specialist Station (L10 and L11) and consists of two CRT's and one or two keyboards with associated electronics units. One CRT will display alphanumerics and graphics in tricolor and one will have the capability to display both video and overlay symbolic data (alphanumerics and graphics) in black and white. The MFDS is required to interface with either the Orbiter data bus or the Spacelab data buses, and will contain sufficient memory to support core C&D software.

The MFDS is the primary method the payload specialist will use to perform experiment setup and display experiment data. He will use the MFDS to assist in such tasks as experiment

SHUTTLE AFT FLIGHT DECK - C&D UTILIZATION

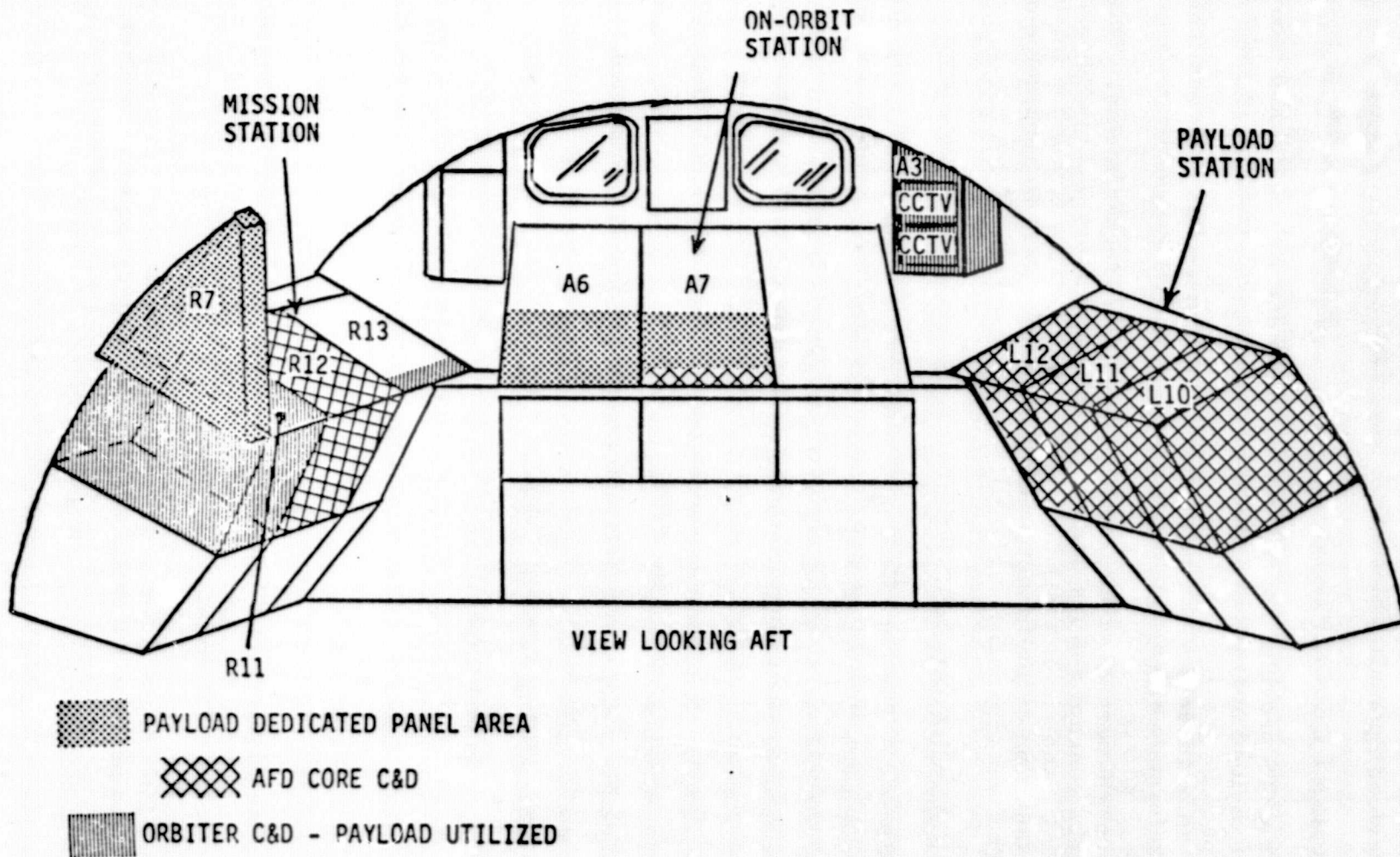
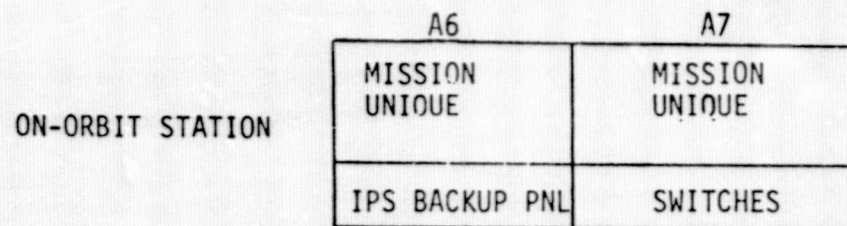
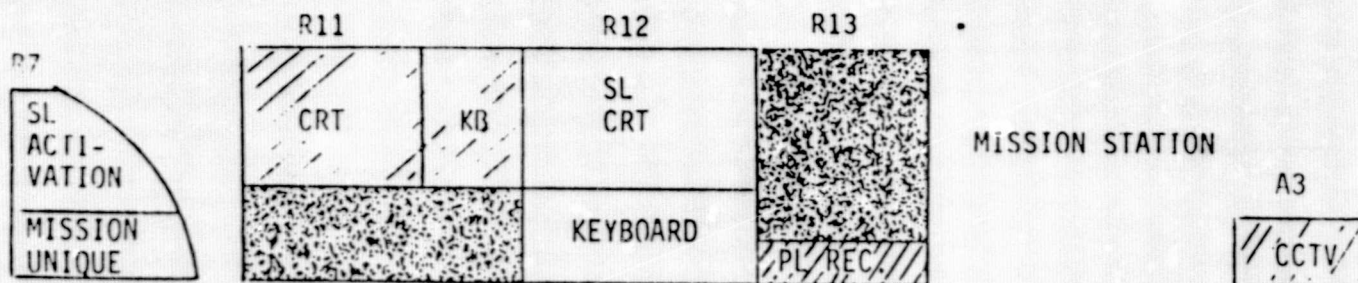
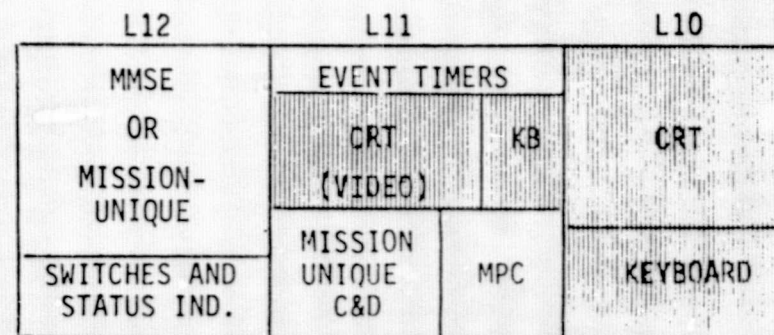
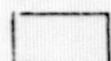


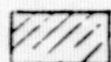
Figure 1



PAYLOAD STATION



 PAYLOAD DEDICATED PANEL AREA

 STANDARD ORBITER EQUIPMENT - PAYLOAD UTILIZED

 ORBITER DEDICATED PANEL AREA

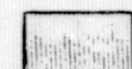
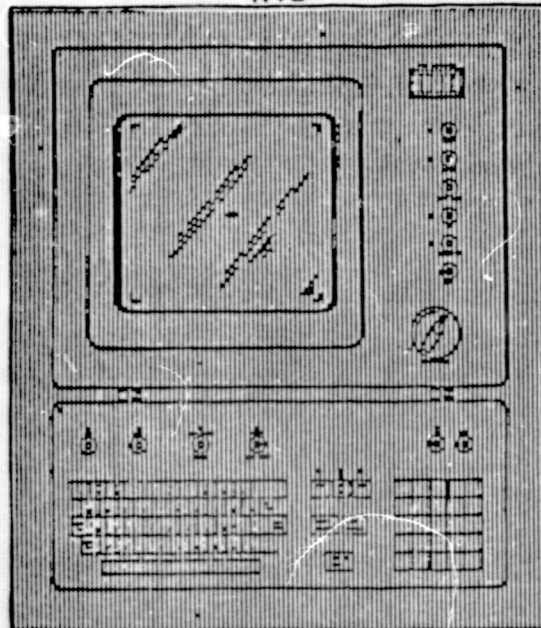
 MFDS

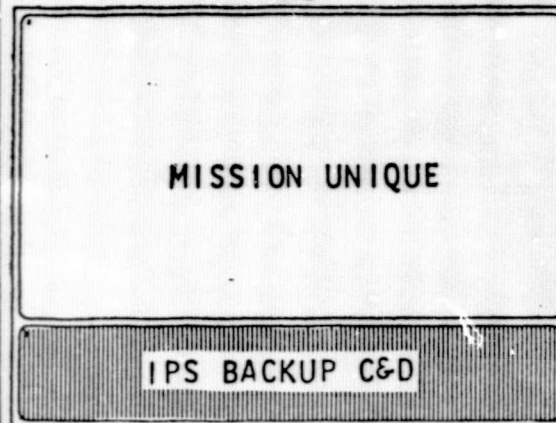
Figure 2

R12

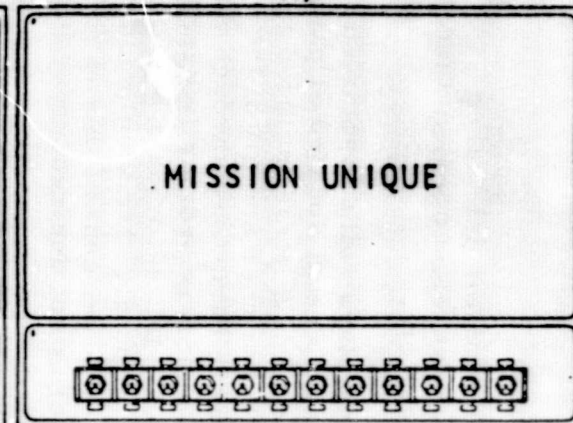


 GFE

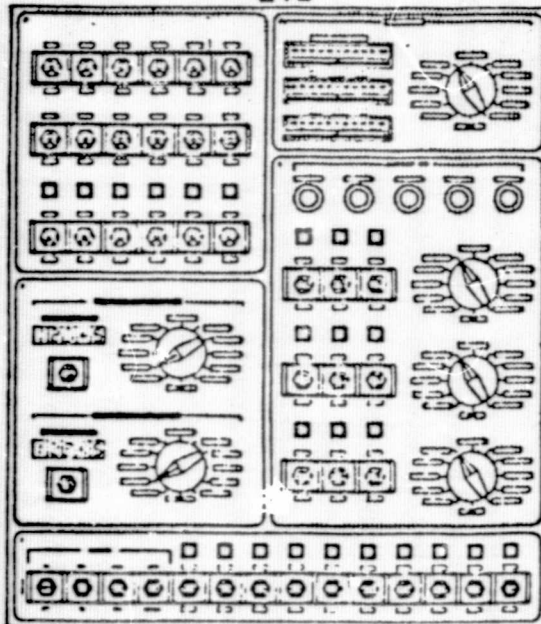
A6



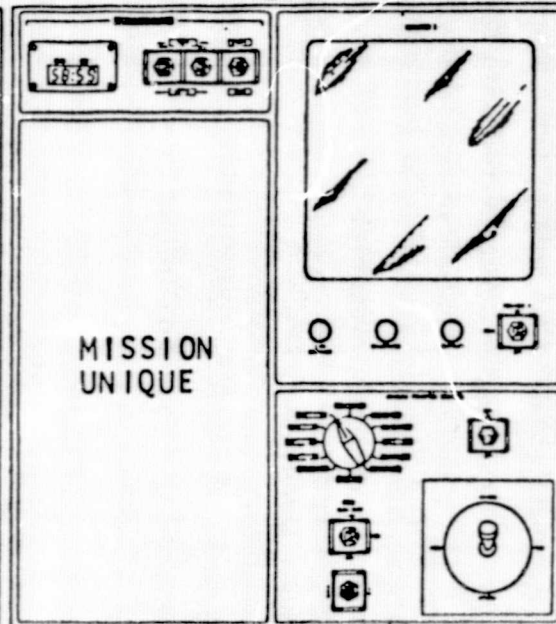
A7



L12



L11



L10

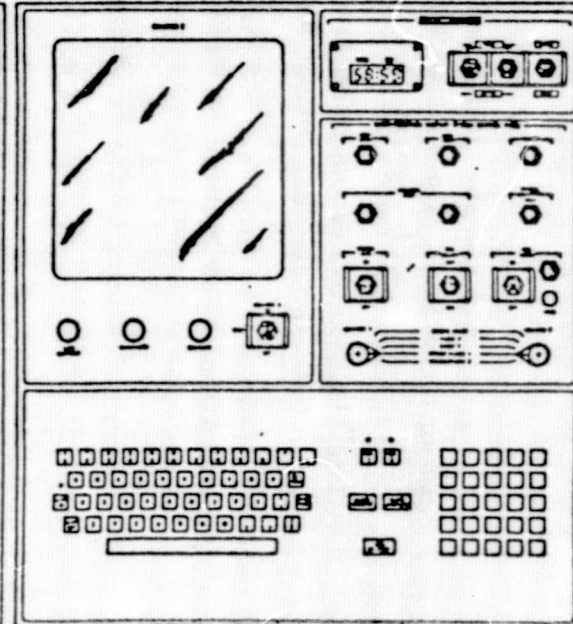


Figure 4 - PSS C&D Concept for New Development

activation, setup, and calibration. The payload specialist will also perform the experiment and monitor data taken using the MFDS. He will be able to point telescopes, display data plots, monitor experiment status, etc.

The MMSE covers the controls and displays (with associated electronics), apart from the MFDS equipment, located at panels L11, L12, and A7. Table 1 lists the MMSE items included in the conceptual baseline. Some of the switches and all of the potentiometers located on panel L12 are hardwired through the X₀ 576 bulkhead while the remaining MMSE is ordinarily wired to the experiment RAU at the payload station for data bus communications to the experiment computer. Mission unique connectors are provided to wire up to 50 percent of this MMSE to the X₀ 576 bulkhead if RAU control is not desired.

b. What Types of Payloads:

Automated, Automated with IUS, Spacelab

c. What STS Elements are Involved:

Orbiter, Spacelab

d. Describe Interface Requirements:

- Systems Interfaces - Standard
Orbiter Systems, Spacelab Systems,
Payload-Unique Systems
- Hardware
- Power
- Wiring

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

Spacelab 2 - 1980

6. IDENTIFY ALL POTENTIAL USERS:

NASA and Civil - All payloads are potential users

DoD - No DoD applications defined, may be used for switching

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

1979-1981 7 Flights

1982-1991 30 Flights Per year

Table 1

EQUIPMENT LOCATION	DESCRIPTION
L12	● Two-Position Momentary Toggle Switches (13) ● Three-Position Indicators (10) ● Three-Position Toggle Switch (1) ● 12-Position Rotary Switch (2) ● Two-Position Momentary Toggle Switch (2) ● Legends (LEDs) (4) ● Digital Displays (5-digit) (2) ● Two-Position Locked Toggle Switch (18) ● Three-Position Indicators (6) ● Analog Meters (3) ● 12-Position Rotary Switch (1) ● Potentiometers, Rotary (5) ● 12-Position Rotary Switch (3) ● Two-Position Momentary Toggle Switch (9) ● Three-Position Indicators (9)
L11	● Event Time Display, 4-digit (1) ● Two-Position Momentary Toggle Switch (3) ● Legend (LED) (1) ● 12-Position Rotary Switch (1) ● Three-Position Toggle Switch (1) ● Two-Position Momentary Toggle Switch (2) ● Manual Pointing Controller (Pitch/Yaw) (Joystick) (1)
A7	● Two-Position Locked Toggle Switch (12)

Proposed Complement of MMSE

8. EQUIPMENT COST ESTIMATE:

Non-Recurring - TBD

Recurring - TBD

Development Schedule - Approximately 36 months for complete system.

9. POTENTIAL VALUE OF EQUIPMENT:

Individual programs would not have to provide monitoring and control equipment. This equipment could satisfy approximately 90 percent of user C&D requirements.

10. STATUS:

Detailed study by MMC established C&D concept. Development of panels L-10 and L-11 to support Spacelab 2 proposed; decision pending.

11. REFERENCES(S) FOR ADDITIONAL DATA:

- a. MCR-76-403, Final Study Report, Payload Specialist Station Study, Vols. I, II, III, Nov. 1976, Martin Marietta Corporation.
- b. MCR-76-202, Catalog MMSE, June 1976, MMC.
- c. MCR-76-202, Final Report, MMSE, Volume II, Book 1, Requirements, Definition, and Design Analysis.

12. CONTACT:

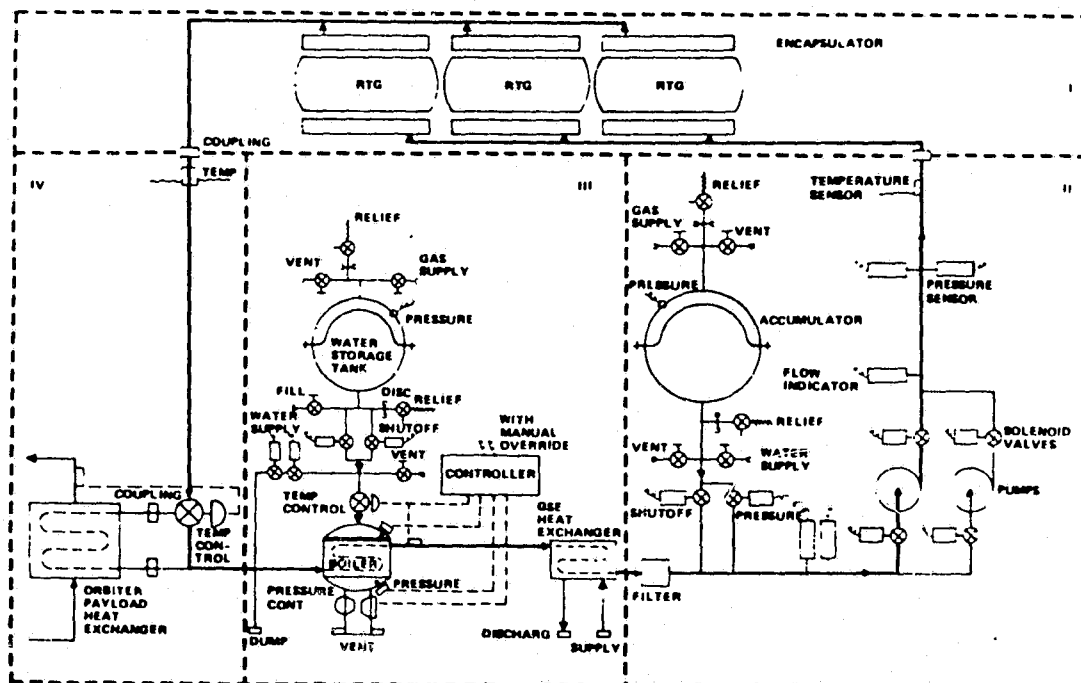
Rein Ise, NASA/MSFC

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Radioisotope Thermoelectric Generator (RTG) Cooling Unit, No. TBD

2. EQUIPMENT DESCRIPTION:

The RTG cooling unit consists of pumps, a supplementary heat exchange (boiler), water storage tank, water and interconnecting lines and control valves. During operation excess thermal energy is used to convert stored water to expendable steam. The baseline cooling system is shown in the figure. The system uses water as both the circulant and evaporative fluids.



3. PHYSICAL CHARACTERISTICS:

See Table in Section 4 for Weights

4. PURPOSE AND INTENDED APPLICATION:

a. Capability and Function:

A comparison of payload requirements with carrier capabilities shows that the Orbiter heat rejection during ascent, descent, and postlanding is generally below payload needs. If multiple payloads are considered (with or without RTGs), the incompatibility becomes worse.

Weight (lb)	Dry Hardware	237	
	Installation Hardware	73	
	Encapsulator System	87	
	Liquid in System	92	
	Evaporant	374	
	Controls	33	
	Wiring Harness	35	
	Crowage System	15	
Total		946	lb
Power	Pumps	35	
	Instrumentation	40	
	Controls	20	
(Continuous)	Total	95	watts
(Peak)		185	watts
Flow	Circulating Loop:	720	lb/hr
	Evaporant Loop:	30	lb/hr Maximum
		20	lb/hr Nominal - Orbit
Pressure	Circulating Loop	50	psia
	ΔP Across Pump	20	psia
	Boiler Operating Pressure	0.25	psi Above Ambient (60°F Nominal - Orbit)

b. What Types of Payloads:

Automated With IUS

c. What STS Elements are Involved:

Orbiter, IUS

d. Describe Interface Requirements:

TBD 1983

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

TBD (Flights 27, 28)

6. IDENTIFY ALL POTENTIAL USERS:

NASA: PL-01-A, PL-12-A, PL-13-A, PL-14-A, PL-22-A,
PL-28-A, PL-31-A (See Reference b)

DoD: Specs will be defined when payload definition is available.

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

2 Kits Required

8. EQUIPMENT COST ESTIMATE:

Non-recurring - \$1.6 Million

Recurring - \$1 Million (1 Unit)

Development Schedule - TBD

9. POTENTIAL VALUE OF EQUIPMENT:

Eliminate redundant development costs for individual program designs.

10. STATUS:

Budgeted by Headquarters. Action deferred to GFY78.

11. REFERENCES(S) FOR ADDITIONAL DATA:

- a. Study of Methods of Providing Thermal Control for RTGs Used on NASA Payloads, Final Report, JPL Contract No. 954094, April 1975
- b. MCR-76-202, MMSE Final Report, Vol II Book 1 - Requirements, Definition and Design, June 1976, MMC.
- c. ATR-76(7362)-1, Vol III, STS Users Study (Study 2.2) Final Report Vol III: Ancillary Equipment Study, 1 Nov 1975, Aerospace Corp.

12. CONTACT:

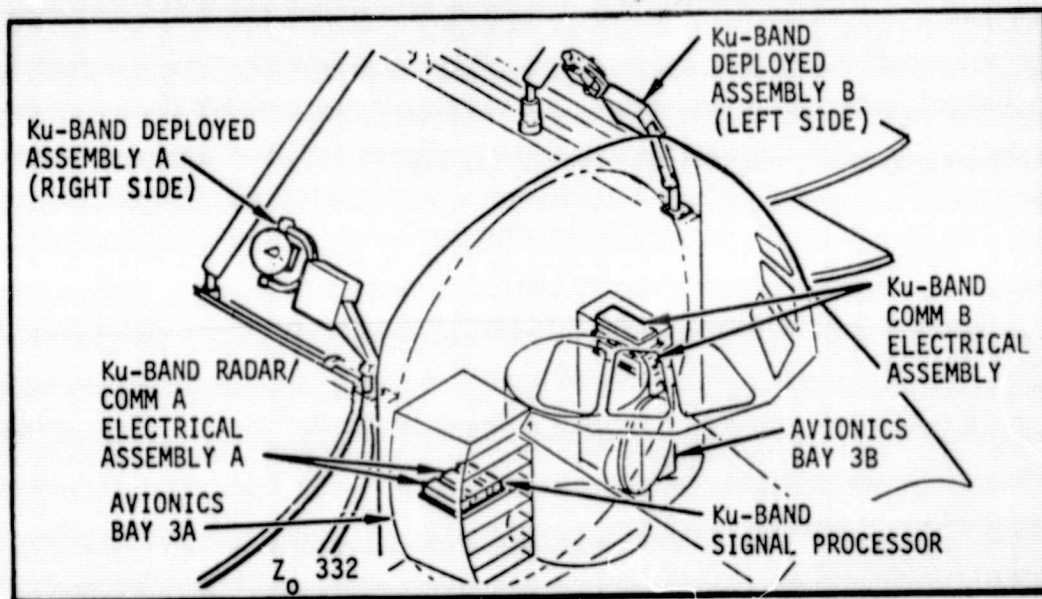
TBD

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Second Ku-Band Antenna (Ku-Band Communication B), No. TBD

2. EQUIPMENT DESCRIPTION:

The Orbiter Ku-Band System is designed for both communication and rendezvous radar with both operational modes using a common parabolic antenna. Two Ku-Band systems are provided as shown in the figure. The right-hand side deployed assembly is the operational unit while the lefthand boom is provided as a kit and installed only if a payload requires additional communication coverage. The transmitter (which is passively cooled) and the gimbaled antenna are mounted on a deployable boom. A major driver on the antenna size is the available envelope in the stowed position. It is constrained by the payload doors on the outside and by the antenna mount and gimbal mechanism.



3. PHYSICAL CHARACTERISTICS:

- a. Size:
- b. Weight: 263 lbs

4. PURPOSE AND INTENDED APPLICATION:

a. Capability and Function:

The orbiter Ku-band radar/communication subsystem is packaged in two sets of assemblies. One set, Radar/Comm A, is carried aboard the orbiter as standard equipment. Radar/Comm A consists of a deployable antenna assembly and an electrical assembly located in avionics Bay 3A. The antenna is mounted on the starboard payload bay door longeron at Station X₀ 662. During ascent, the antenna is stowed in the space between the payload bay door radiator panels and the 15-foot-diameter payload bay clear volume. The antenna is deployed outboard of the orbiter mold line after the payload bay doors have been opened.

In the radar mode, the Ku-band subsystem can detect, acquire, and automatically track at a range of 19 kilometers passive targets with equivalent radar cross-sections of one square meter and Swerling Case 1 scintillation characteristics. The maximum tracking range increases to 560 kilometers when the target is equipped with an appropriate beacon transponder. The radar can acquire a target in 60 seconds, or less, after being directed along the expected target vector, and can provide line-of-sight (LOS) range to the target, range rate, angles relative to the orbiter rendezvous axis (-Z axis), and angle rates, from the maximum range down to a minimum range of 30 meters.

The Comm A Ku-band communications unit shares the radar antenna and pedestal. Two different modes are available for the transmission of data to the ground through tracking and data relay satellites (TDRS). In Mode 1, up to 50 megabits per second (mbps) of wideband data from an attached payload, plus up to 2 mbps of operational, stored, or experiment data and 192 kbps operational data can be transmitted. Mode 2 transmissions can consist of 4.5 mbps of analog (TV) data from either the orbiter or an attached payload, or 4 mbps of payload digital data, plus up to 2 mbps of stored or experiment data and 192 kbps of real-time operational data from the orbiter. The forward (ground-to-orbiter) link can carry 216 kbps of medium band-width data, 72 kbps of operational data for the orbiter, 128 for the payload, and 16 kbps of overhead.

If continuous Ku-band data transmission is required over more than 40 percent of an orbiter orbit, then a second set of Ku-band communication assemblies is required. This assembly kit (Comm B) consists of a deployable antenna mounted on the starboard payload bay door longeron, plus electrical units housed in avionics Bay 3B. The 263-pound weight of this kit is part of the payload weight allowance. With this kit, the orbiter can communicate with both TDRS's, sequentially, without disrupting the flow of data during the "handoff" period.

b. What Types of Payloads:

Spacelab, Automated, Automated With IUS

c. What STS Elements Are Involved:

Orbiter

d. Describe Interface Requirements

Mechanical Mounting

Electrical Power

Avionics

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

OFT FLTS 1979

6. IDENTIFY ALL POTENTIAL USERS.

All NASA and Civil payloads
DoD payloads (See Ref. e)

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

1979-1981

1982-1991

8. EQUIPMENT COST ESTIMATE:

Non - Recurring

Recurring - \$3.7M First Unit

Development Schedule - Proceed Nov 1976 Deliver First Unit Nov 1979

9. POTENTIAL VALUE OF EQUIPMENT:

Improved Coverage With High Data Rate Capability

10. STATUS:

Design in Work

11. REFERENCE(S) FOR ADDITIONAL DATA

- a. Ku-Band Integrated Radar and Communication Equipment for the Space Shuttle Orbiter Vehicle Conceptual Design Review Briefing, 18-20 Jan 1977, Hughes Aircraft Company
- b. SSV75-28 Shuttle Orbiter Ku-Band Radar/Communications Subsystem Bidders Seminar, 13-14 Aug 1975 Rockwell International
- c. SSV 76-32 Space Shuttle System Summary, July 1976 Rockwell International
- d. SD 76-SH-0251, Shuttle Orbiter Mission Kit Status, Semiannual Report, Dec 1976, Rockwell International
- e. SAMSO TR-76-212-III, DoD Shuttle Integration Support Study, Vol III, DoD/STS Avionics/Electrical Trades and Analysis, Final Report, Nov 1976, Rockwell International

12. CONTACT:

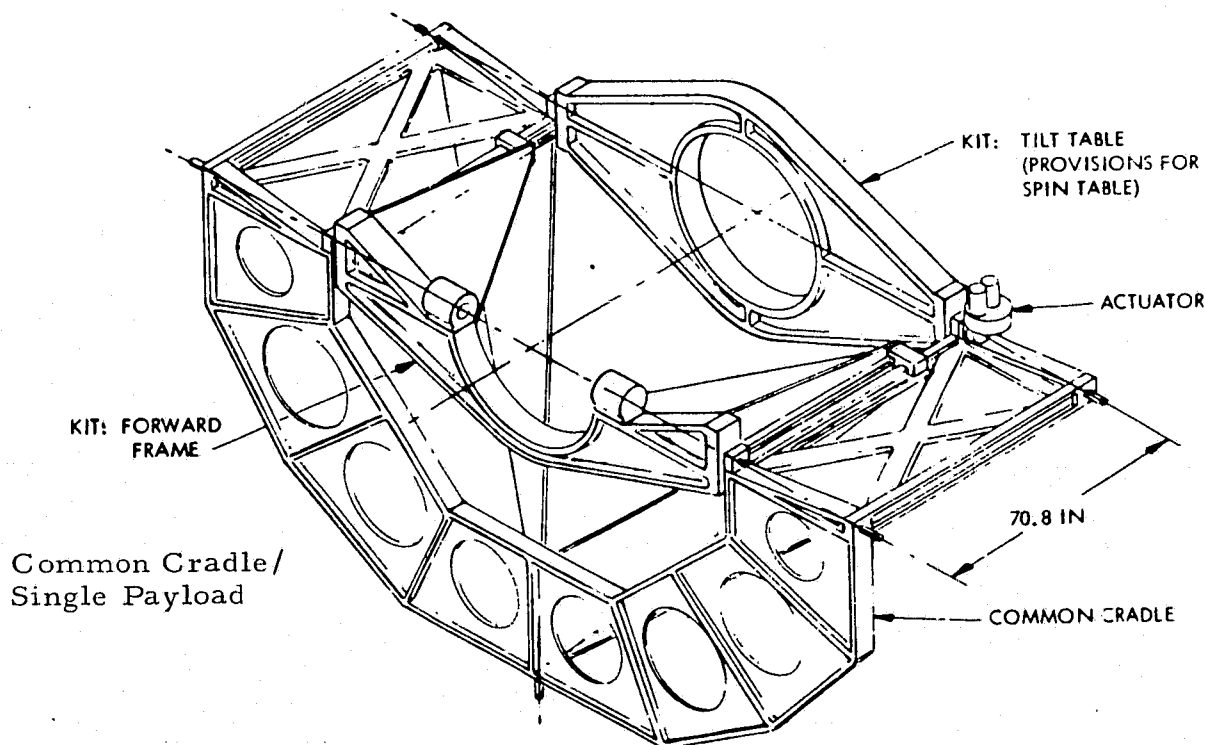
J. Heberlig NASA/JSC

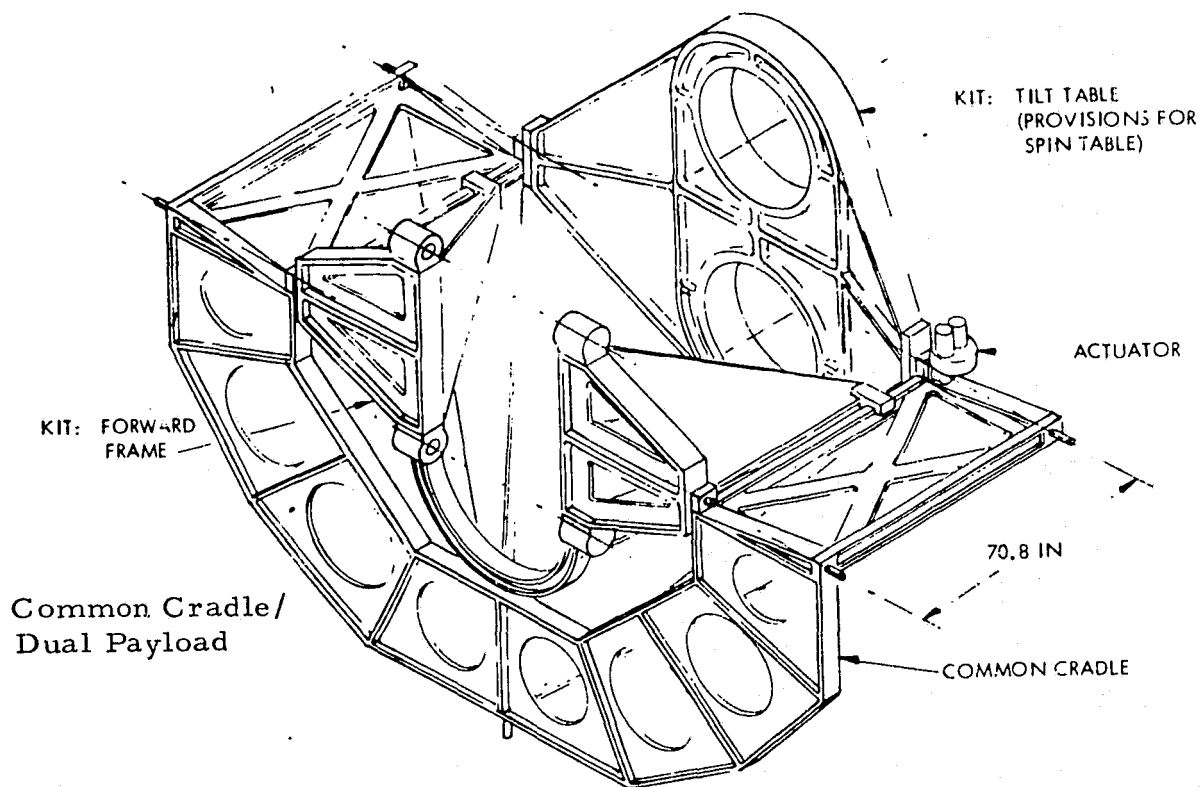
1. NAME OF ITEM AND IDENTIFYING NUMBER:

Common Cradle/Non-IUS Payloads, No. TBD

2. EQUIPMENT DESCRIPTION:

This common cradle concept shown in the figures is for the purpose of supporting small diameter, non-IUS payloads in the orbiter bay. Since the payload diameters are small relative to the payload bay diameter, a common module (cradle) is used to extend the payload retention inward to provide structural support of payload-unique modules (kits). The payload support kits contain attachment and release mechanisms and deployment aids such as tilt tables and can include over-and-under dual payload supports. The common cradle must support the payloads/kits for safe ascent, entry, and landing. Suitable elastic characteristics are required to limit dynamic loads on the payloads and thus limit payload transition costs. Other cost objectives of the common cradle approach are to share cradle development costs and reduce acquisition and operations costs by limiting the required inventory.





3. PHYSICAL CHARACTERISTICS:

- a. Size: See Figures
- b. Weight: TBD

4. PURPOSE AND INTENDED APPLICATION:

- a. Capability and Function:

The common cradle concept incorporates a single piece design with a right triangular-shaped side view. The payload (spacecraft assembly) with adapter is mounted in a horizontal attitude. Deployment requires tilt up, spring release, and spin up (for some payloads). The common cradle concept offers an effective method to support and deploy the DOD non-IUS spacecraft assemblies. Program development cost is expected to be minimized because of the one-time-only development for the common cradle. Only adapter kits need to be developed for each new spacecraft/kick stage interface.

The machined frame design was selected because mechanical frames provided greater latitude in locating hard points for kit interfaces. Integral bolting pads can be located at several positions along frame caps for attaching kits. Previous analyses conducted for this configuration indicate improved dynamic response compared to other designs. The basic structural element that will be common to all mated payloads consists of a primary forward frame, an aft canted frame, and two shear beams. Frame material is of 2124 aluminum. Since a common cradle will experience greater utilization, fatigue and stress corrosion must be considered. The size of the frames dictate that they be made in segments and bolted together. This allows for the availability of standard-sized material and would facilitate the machining process.

The payload mates with the cradle in a position that places the payload cg as close to the forward frame attachments as possible. All axial loads and primary radial loads are reacted at the forward frame. The aft attachments react vertical loads and pitching moments. By reacting lateral loads under the payload cg, coupling is minimized. This system of loads reactions has proved to yield better payload response to dynamic influence. The marmon clamp interface at the aft kick stage structure/tilt table is removed from the path of high axial loads (including crash loads). Marmon clamps that interface the spacecraft to the propulsive stages are downstream of the forward trunnions in a crash load condition and react only spacecraft loads. The heavy kick motors create compressive loads that are reacted directly by the forward trunnions.

For a single payload, the forward trunnions and latches that attach the payload to the cradle kit are of conventional design. The dual over/under GPS payload kit uses trunnions that retract into the cradle kit to provide a clear envelope for payload vertical translation when tilted for deployment.

- b. What Types of Payloads:
Automated (Non-IUS)
- c. What STS Elements are Involved:
Orbiter
- d. Describe Interface Requirements:
Longeron Trunnions
Keel Trunnion

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

TBD

6. IDENTIFY ALL POTENTIAL USERS:

NASA - All Non-IUS Automated

DOD - GPS, DMSP, Also STP Payloads (See Ref. a)

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

More than 100 over a ten year period

8. EQUIPMENT COST ESTIMATE:

Non-recurring -

Recurring -

Development Schedule -

9. POTENTIAL VALUE OF EQUIPMENT:

Each payload would develop its own cradle rather than adapter kits for the common cradle

10. STATUS:

Small preliminary study completed by Rockwell International -
No funding to continue.

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. SAMSO TR-76-212-XIII, DoD Shuttle Integration Support Study, Vol XIII, DoD-STP/STS Mixed Payload Considerations, Final Report, Nov. 1976, Rockwell International

12. CONTACT:

TBD

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Multi-use fluid line kits

No. TBD

2. EQUIPMENT DESCRIPTION:

A large number of SSPD payloads identify the need for some type of fluid or gas servicing after the payload is installed in the Orbiter. Approximately TBD of Spacelab payloads and TBD of automated payloads have some type of servicing requirement.

To date, no carrier has made any provisions for providing these types of services. Consequently, a generic classification of multi-use fluid line kits has been defined to accommodate these requirements. Preliminary analyses have resulted in five specific fluid line kits to be used in conjunction with Spacelab and automated payloads.

Although concepts have been proposed for these kits, significant work must be performed before any hard recommendations can be made. For instance, payload requirements need better definition; carrier capabilities have to be defined better; and finally the cost effectiveness of these fluid lines has to be established. In summary, this item should be treated as very soft pending further study.

Types of fluids/gases are the following:

Fluids/Gases

Fluids

- Liquid Hydrogen
- Liquid Helium
- Liquid Oxygen
- Liquid Nitrogen
- Hydrazine Propellants
- Oxidizer Propellants

Gases

- Gaseous Hydrogen
- Gaseous Helium
- Gaseous Oxygen
- Gaseous Nitrogen
- Hydrazine Relief/Vent
- Oxidizer Relief/Vent

3. PHYSICAL CHARACTERISTICS:

TBD

4. PURPOSE AND INTENDED APPLICATIONS

a. Capability and function:

Fluid and gas services for the three carriers are defined in the table. All three carriers make provisions for the payload fluid line installation. However, the fluid lines themselves are generally payload provided. Certain of the Orbiter panels have restrictive constraints placed on their usage. For example, the prelaunch panel (T-4) is closed at T-4 hours and the launch umbilical panel (T-0) covers are closed during ascent and descent.

Orbiter Provides fluid lines to the Orbiter interface panels (payload bay Station X_o 576, X_o 1307 and preflight service panel station TBD) (Ref 1).

Spacelab Provides fluid-line feedthrough on module bulkheads and assigns an area for experiment fluid lines within the support tunnels that bridge between the Orbiter, the module, and the pallets (Ref 2).

IUS Payload provides fluid lines (payloads lines are routed via the IUS and its cradle) (Ref 3).

- References:
- 1) Space Shuttle System Payload Accommodations, JSC 07700, Volume XIV, Rev C, July 3, 1974
 - 2) Spacelab Payload Accommodations Handbook, October 1974
 - 3) Reference Information, IUS Satellite Interfaces, "IUS/Tug Payload Requirements Compatibility Study," July 1974

b. What types of payloads:

Automated, automated with IUS, Spacelab

c. What STS elements are involved:

Orbiter, IUS, Spacelab

d. Describe interface requirements:

TBD

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

TBD

6. IDENTIFY ALL POTENTIAL USERS:

NASA } TBD

DoD DMSP (GN₂ Purge/Coolant) (See Reference d)

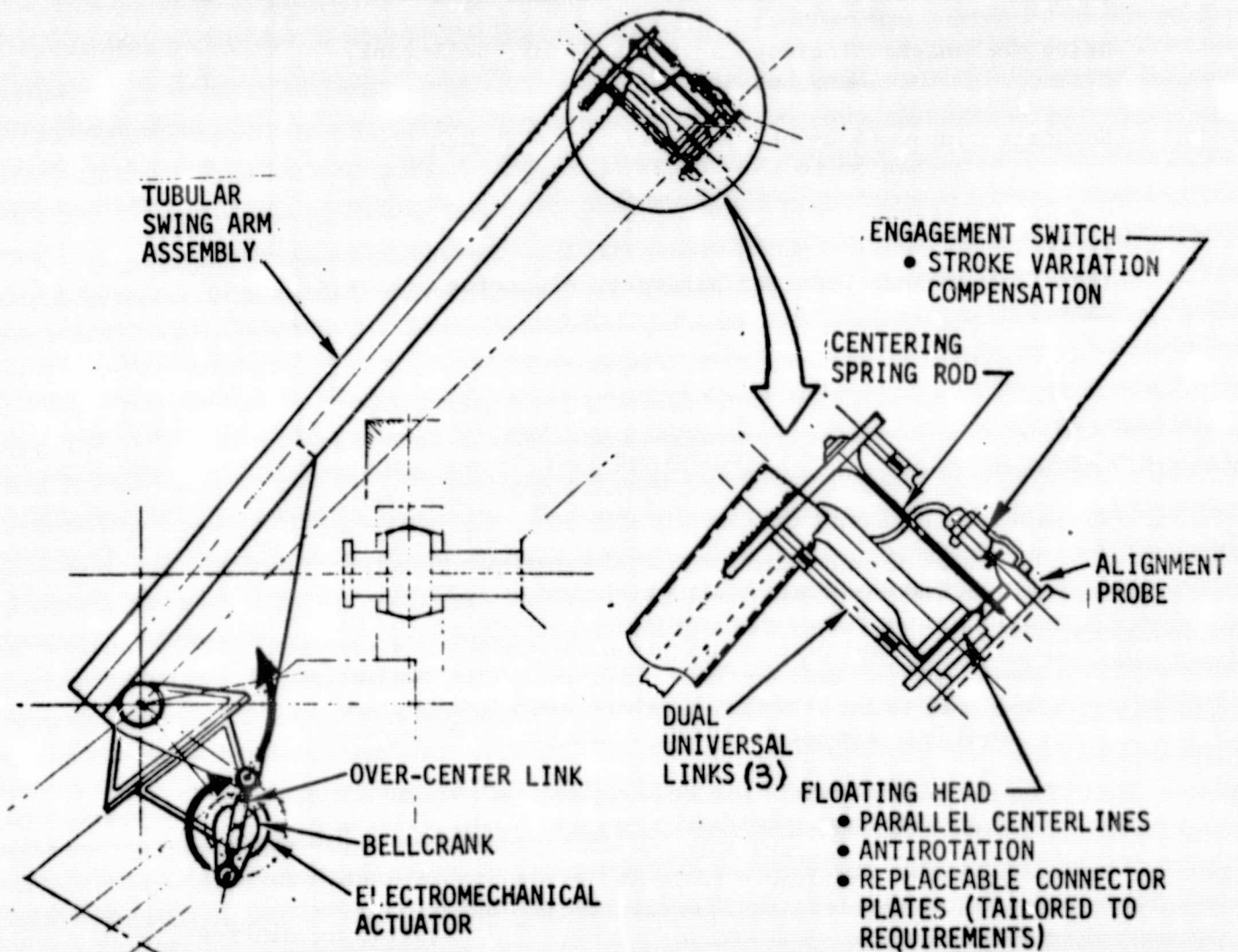
7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:
TBD
8. EQUIPMENT COST ESTIMATE:
TBD
9. POTENTIAL VALUE OF EQUIPMENT:
Fluid lines payload provided
10. STATUS:
Noted as potential mission kit, not under study, not funded
11. REFERENCE(s) FOR ADDITIONAL DATA:
 - a. MCR-76-202, MMSE Final Report, Vol II, Book 1, Requirements, Definition, and Design Analysis, June 1976. Martin Marietta
 - b. SD 75-SA-0182, Use of STS Equipment (Subsystems/Components) for MMSE, Final Briefing, 10 Dec 1975, Rockwell International
 - c. SD 76-SH-0251, Shuttle Orbiter Mission Kit Status, Semi-Annual Report, Dec 1976, Rockwell International
 - d. DoD Shuttle Integration Support Study, Final Briefing, 12th Tech. Review, Integrated Payload/Shuttle Analysis Results, 8 Dec 1976, Rockwell International
12. CONTACT:
TBD

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Umbilical Connector, No. TBD

2. EQUIPMENT DESCRIPTION:

A design concept shown in the Figure is a swing arm concept controlled by an electromechanical rotary actuator that drives a dual overcenter bellcrank linkage. Primary alignment is through the inherent stiffness of the mechanism. Fine alignment is through use of a triple dual-universal linkage located on the head.



Umbilical Disconnect/Reconnect Concept

3. PHYSICAL CHARACTERISTICS:

- a. Size: TBD
- b. Weight: See Table

Item	Pounds
Head: Includes plates, universal linkages, centering device, one No. 24 connector and one GN ₂ coupling	2.2
Linkage: Includes arm (aluminum tube) and base	1.6
Drive Mechanism: Includes actuator, link, bellcrank, and housing	7.2
Support: Includes braces and devices to attach the mechanism to the cradle	3.0
Total	14.0

(Does not include mounting hardware, electrical cable or GN₂ line.)

4. PURPOSE AND INTENDED APPLICATION:

a. Capability and Function:

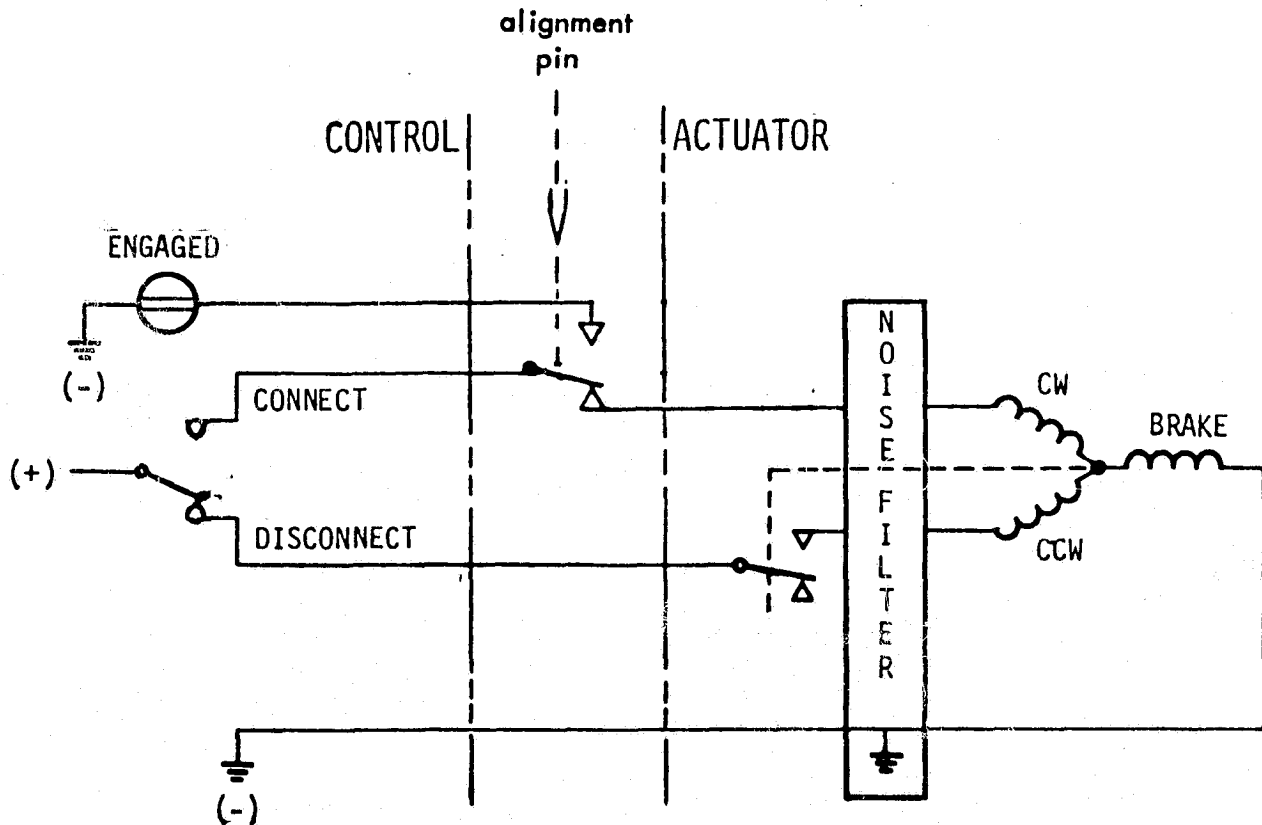
This item provides an umbilical interface between the orbiter and the spacecraft which can be disconnected and subsequently remated remotely. The DMSP spacecraft was used as a baseline configuration to provide realism and complexity in configuration matching. But the design itself was to be generic in nature such that it could be used for multiple spacecraft with minimum modifications.

The simplest system for separation and reconnection appears to be an electromechanical rotary actuator driving a dual over-center bellcrank linkage. The dual overcenter feature provides the maximum ratio at the maximum load, provides sine wave acceleration/deceleration, and provides a positive lock at each end of stroke. This system minimizes weight and possible system costs.

The umbilical is mated by driving the arm toward its inboard position. The mechanism is designed to apply a mating force at the connector of 100 pounds. This provides for connecting/disconnecting a standard number 24 shell size connector with a maximum of 128 pins for a 96-pound maximum force. When this force is exceeded by TBD percent, the motor clutch slips and the motor is automatically turned off.

Connector engagement is verified by a lamp illuminated at the payload station control unit. The "engaged" lamp (see schematic below) operates when a microswitch located within the alignment mechanism housing is activated. The switch actuator is the alignment probe located on the satellite umbilical plate.

To separate the umbilical, the arm is driven in the opposite direction (outboard). The linkage rotates away from the payload to a perpendicular position (Z plane). Because the umbilical separation is automatic, no position indicator is provided. The motor is simply turned off by the position switch when the linkage is in the proper position.



Controls Schematic

b. What Types of Payloads:

Automated, Automated with IUS

c. What STS Elements are Involved:

Orbiter

d. Describe Interface Requirements:

Mechanical Mounting to Cradle

Electrical Power

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

TBD

6. IDENTIFY ALL POTENTIAL USERS:

All NASA and Civil payloads having electrical connections with orbiter/IUS

DoD - DSP, FSC, GPS, SMSP (See Ref. a, b)

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

TBD

8. EQUIPMENT COST ESTIMATE:

Non-recurring - \$113,500

Recurring - \$75,700/Unit

Development Schedule - TBD

9. POTENTIAL VALUE OF EQUIPMENT:

Payload unique disconnect, reconnect possible by EVA

10. STATUS:

Concept from study by Rockwell International; no funding

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. SAMSO TR-76-212-V, DoD Shuttle Integration Support Study Final Report, Vol V, Structural - Mechanical Trades and Analysis November 1976, Rockwell International

- b. SAMSO TR-76-212-IV, DoD Shuttle Integration Support Study
Final Report, Vol IV, DoD/STS Payload Installation Configurations,
Nov. 1976, Rockwell International

12. CONTACT:

TBD

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Avionics Equipment, No. TBD

2. EQUIPMENT DESCRIPTION:

Includes:

- Multiplexer/Demultiplexer (MDM)
- Electrical Isolation, Conditioning, and Distribution Assembly (EICDA)
- Dedicated Recorder
- PCM Unit
- DC-DC Converter/Regulator

3. PHYSICAL CHARACTERISTICS:

- a. Size: }
b. Weight: } See Individual Item

4. PURPOSE AND INTENDED APPLICATION:

- a. Function and Capability:

See individual item

- b. What Types of Payloads:

Automated, Automated with IUS

- c. What STS Elements are Involved:

Orbiter

- d. Describe Interface Requirements:

See individual items

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

See individual item

6. IDENTIFY ALL POTENTIAL USERS:

See individual item

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

See individual item

8. EQUIPMENT COST ESTIMATE:

See individual item

9. POTENTIAL VALUE OF EQUIPMENT:

Payload unique equipment would have to be provided

10. STATUS:

See individual item

11. REFERENCE(S) FOR ADDITIONAL DATA:

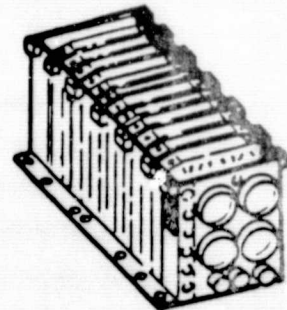
- a. SAMSO TR-76-212-II, DoD Shuttle Integration Support Study, Final Report, Vol II, Avionic Summary, Nov 1976, Rockwell International
- b. SAMSO TR-76-212-III, DoD Shuttle Integration Support Study, Final Report, Vol III, DoD/STS Avionics/Electrical Trades and Analysis, Nov 1976, Rockwell International
- c. DoD Shuttle Integration Support Study, Final Briefing, 12th Tech Review, Integrated Payload/Shuttle Analysis Results, 8 Dec 1976, Rockwell International

1. NAME OF ITEM AND IDENTIFYING NUMBER:

Multiplexer/Demultiplexer 330-03-04-02

2. EQUIPMENT DESCRIPTION:

Multiplexer/demultiplexer will provide bidirectional transfer of information at multiplexed rates exceeding 5 Mbps between remote sensors and data handling and control and display equipment located in the PSS or Spacelab.



3. PHYSICAL CHARACTERISTICS:

a. Size: TBD

b. Weight: TBD

4. PURPOSE AND INTENDED APPLICATION:

a. Capability and Function:

The MDM is used for bidirectional transfer of information between remotely located sensors and data handling and control and display equipment located either in the Spacelab Module or the Orbiter PSS station. A number of serial data streams with multiplexed rates of 5 Mbps or greater are transmitted and/or demultiplexed for onboard displays and processing as well as interfacing with the Spacelab Data Handling system for recording or transmission to ground. Conversely, low rate command data are routed from the crew station or payload computer via the MDM for instrument operation.

b. What Types of Payloads:

Spacelab, Automated

c. What STS Elements are Involved:

Orbiter, Spacelab

d. Describe Interface Requirements:

Payload Specialist Station

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

OFT #2

6. IDENTIFY ALL POTENTIAL USERS:

NASA: AS-01, 03, 04, 15, 63-S; AP-06-S; SO-01, 11, 15, 17-S; ST-08-S

DoD: DMSP, DSP, FSC, GPS (See Reference d)

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

1979 - 1981

1982 - 1991

8. EQUIPMENT COST ESTIMATE:

Non-recurring - \$350,100

Recurring - \$315,000

Development Schedule: Start Design July 1978; Deliver August 1979

9. POTENTIAL VALUE OF EQUIPMENT:

In the absence of an MDM, the data would be hardwired or routed into either of two Spacelab inputs, the digital data bus or high rate multiplexer. Although the data bus provides bidirectional data transfer and can display these data as well as route the data for record or transmission to the ground, the payload data rates in many cases exceed the data bus capacity. While the high rate multiplexer can handle the data rates, there is no capability to route the multiplexed data into a computer or demultiplexer for display.

10. STATUS:

Headquarters has approved funding

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. MCR-76-202, Final Report MMSE, Vol II Book 1, Requirements, Definition and Design Analysis, MMC, June 1976
- b. MCR-76-220, Final Report MMSE, Vol III Project Cost Estimates MMC, June 1976
- c. MCR-76-202, Final Report MMSE, Catalog MMSE, MMC, June 1976
- d. DoD Shuttle Integration Support Study, Final Briefing, 12th Tech Review, Integrated Payload/Shuttle Analysis Results, 8 Dec 1976, Rockwell International

12. CONTACT: TBD

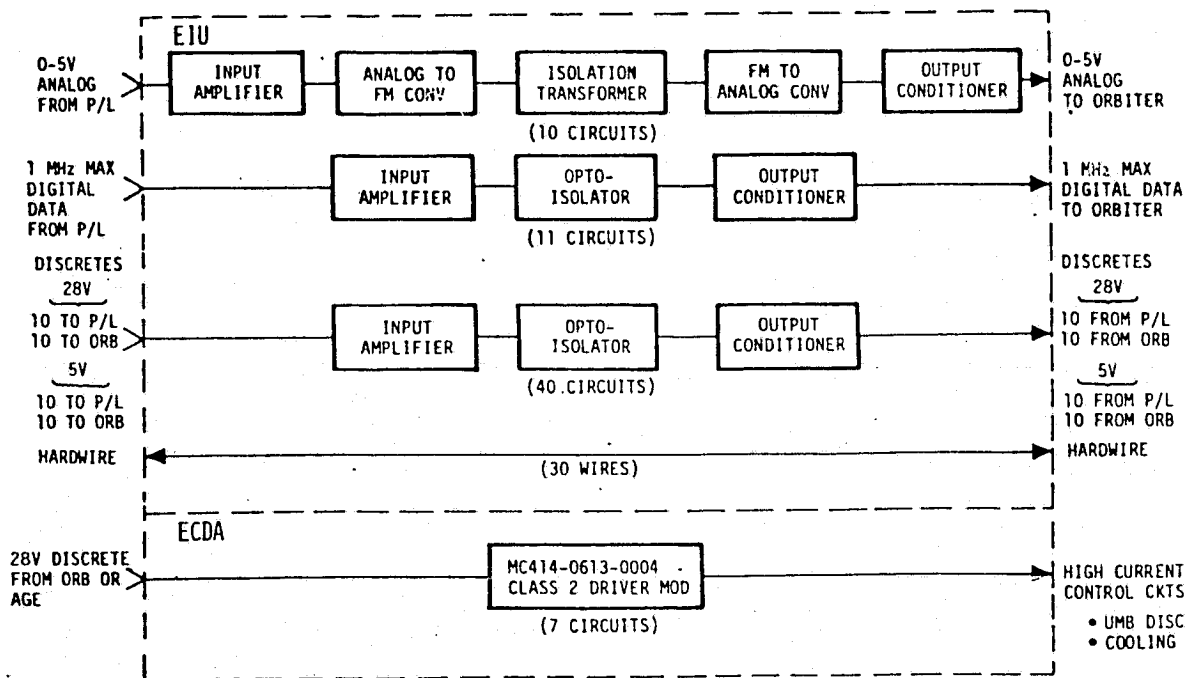
1. NAME OF ITEM AND IDENTIFYING NUMBER:

Electrical Isolation, Conditioning, and Distribution Assembly
(EICDA) - No. TBD

2. EQUIPMENT DESCRIPTION:

The orbiter utilizes the skin and structural members of the vehicle for the power return, the dc voltage between the payload and orbiter varies from location to location. Moreover, these voltages are modulated by the load profile. It is, therefore, necessary to provide electrical isolation for signals crossing the payload/orbiter interface. In addition, load impedances are not necessarily compatible, and signal conditioning may be required. These functions are performed by the electrical isolation unit (EIU).

A number of functions may be required for a particular payload on the cradle. These could include latches, solenoid valves, and other devices. The current and voltage for these devices will usually not be directly compatible with the signals from orbiter or GSE. The required signal conditioning will be provided by the electrical conditioning and distribution assembly (ECDA). A block diagram schematic is shown in the figure below. Each unit has its own internal power supply.



3. PHYSICAL CHARACTERISTICS:

- a. Size: 10 x 10 x 7 Inches
- b. Weight: 20 Lbs

4. PURPOSE AND INTENDED APPLICATION:

a. Capability and Function:

Some payloads cannot properly function in the presence of electrical ground loops generated if they are tied to the Orbiter electrical potential reference plane. The use of this kit will electrically isolate the payload and avoid the ground loop problem.

The EIU will provide a minimum of 10 megohms dc isolation for electrical circuits running between the orbiter and in-bay, attached DOD payloads.

Signal Inputs and Outputs

The EIU will accept inputs from, and provide outputs to, the payload and orbiter. Signals will include 0 to 5 Vdc and 0 to 28 Vdc discretes, 0 to 5 Vdc digital data at rates up to 1 MHz, and 0 to 5 Vdc analog. The EIU will have the capability of isolating the following circuits:

- 10 low-level analog circuits
- 11 1 MBPS digital circuits
- 20 low-level discrete circuits
- 20 high-level discrete circuits
- 7 high current control circuits

b. What Types of Payloads:

Automated, Automated With IUS

c. What STS Elements are Involved:

Orbiter

d. Describe Interface Requirements:

Cabling and Connectors
Mounts on Payload Cradle

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

TBD

6. IDENTIFY ALL POTENTIAL USERS:

NASA and Civil - All Automated and Automated with IUS
DoD - DSP, DMSP, GPS, STP (See Reference b)

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

One unit for each payload on each flight

8. EQUIPMENT COST ESTIMATE:

Non-recurring - \$100,000/Unit
Recurring - \$100,000/Unit
Development Schedule - TBD

9. POTENTIAL VALUE OF EQUIPMENT:

Payloads requiring electrical isolation would have to provide
electrical isolation units

10. STATUS:

PCIN 3464 submitted by system contractor to provide unit
as payload weight chargeable kit

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. SAMSO TR-76-212-II, III, DOD Shuttle Integration Support Study,
Final Report, Vols II, III, Nov. 1976, Rockwell International
- b. DoD Shuttle Integration Support Study, Final Briefing, 12th Tech
Review, Integrated Payload/Shuttle Analysis Results, 8 Dec 1976,
Rockwell International

12. CONTACT:

TBD

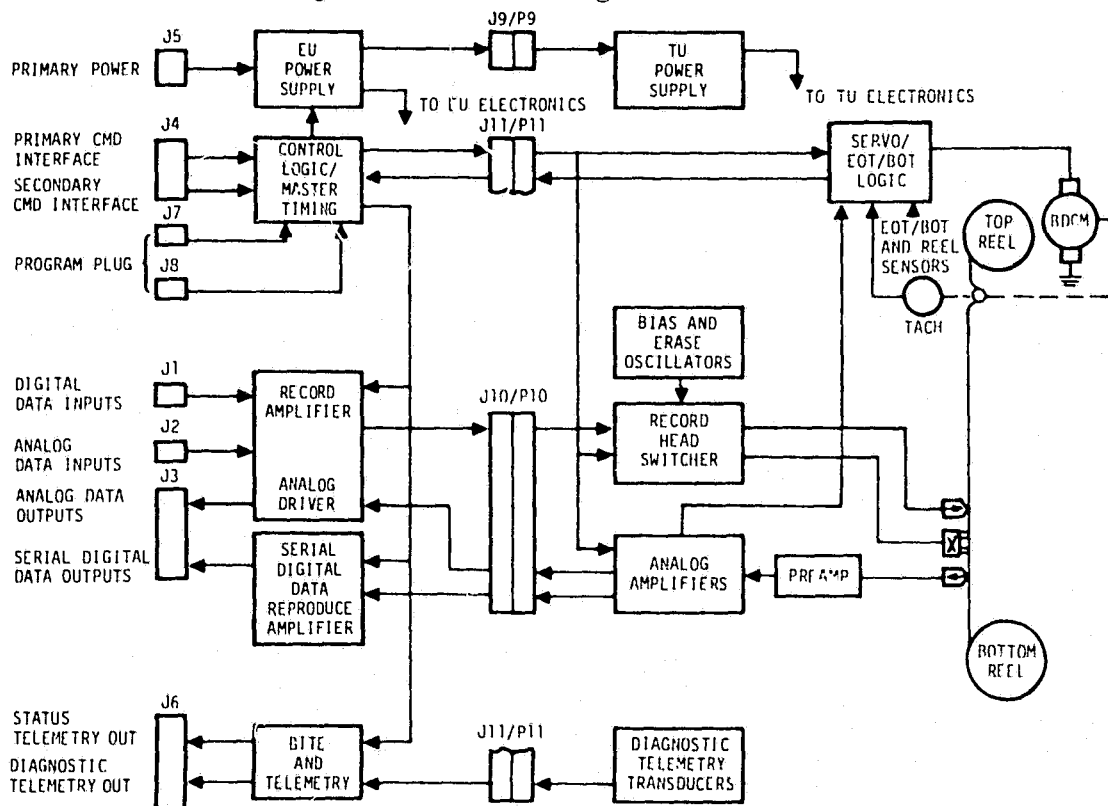
1. NAME OF ITEM AND IDENTIFYING NUMBER:

Dedicated Payload Command Recorder, No. TBD

2. EQUIPMENT DESCRIPTION:

If the payload recorder were to record analog data or other types of data that would interfere with its continuous operation for recording DOD orbiter-initiated commands, an additional payload recorder known as the payload command recorder would be required. This option considers the addition of the same Odetics model currently planned for the payload recorder. This added recorder would function in the manner described. The PCM unit would be required.

The Shuttle standard tape recorder system block diagram is shown in the Figure below. The interfaces with the recorder are shown on the left side of the block diagram. The primary power is 28 ± 4 volts dc. All commands are routed through the J4 connector; and, in conjunction with the program plug, connected to J7 and J8, the control logic interprets all commands and interacts with nearly all other functional elements. Digital data are input through J1, and the analog data can be entered at J2. These data are routed to the record amplifiers, record head switches, and finally to the record heads. All reproduced data are amplified, appropriately conditioned, and outputted through J3. A status and diagnostic telemetry output is provided. The recorder specifications are given in Section 4.



3. PHYSICAL CHARACTERISTICS:

- a. Size: 15 x 19 x 7.75 in.
- b. Weight: 41 Lbs.

4. PURPOSE AND INTENDED APPLICATION:

- a. Capability and Function:

Parameter	Value
Size	15 in. wide x 19 in. long x 7.75 in. high (outline dimensions)
Weight	41 lb
Power (at +28 Vdc input)	Dependent upon operational mode: varies from 15.4 W in standby to 80.6 W in parallel dump at 120 in./sec
Tape	2400 ft x 1/2 in. x 1 mil
Tape speed	14 discrete speed from 6 in./sec to 120 in./sec in one-third octave steps
Flutter	1.5% peak-to-peak maximum for speeds > 10 in./sec 2.0% peak-to-peak maximum for speeds < 10 in./sec
Number of channels	14 parallel (analog or digital) 1 serial (digital only)
Analog channel bandwidth	1.8 kHz to 2 MHz
Analog flux density	125 cycles per in. to 16.7 kilocycles per in.
Analog signal-to-noise ratio (over 3 kHz slot)	45-dB minimum for wavelengths between 60 μ in. and 4000 μ in. 39-dB minimum for wavelengths between 4000 μ in. and 8000 μ in.
Analog total harmonic distortion	2% maximum
Analog frequency response	Unequalized: follows head response curve. ± 1 dB over any 3-kHz slot at frequencies above 11 kHz
Digital data rates	25 kbps to 1.024 Mbps
Digital packing density	4.27 kb/in. to 8.53 kb/in.

Parameter	Value
Digital record format	Biphase level
Bit error rate	5×10^{-7} beginning of life 1×10^{-6} end of life
Command interface	2 identical 16-bit parallel TTL interfaces
Diagnostic telemetry	Provides ten 0- to 5-Vdc diagnostic signals
Status telemetry	Provides 29 bits of status information

The 16 bits are utilized as follows:

- Bits 1 - 3 Select one of eight operational modes.
- Bit 4 Allows direction reversal.
- Bits 6 and 7 Select one of four preprogrammed speeds.
- Bits 8 and 9 Select one of four preprogrammed delay times.
One of the four is always zero.
- Bits 10 and 11 Select one of four preprogrammed run times. One
of the four is always continuous.
- Bit 12 Interrupts any automatic sequence in progress
and determines the function of Bits 13 - 16.
- Bits 13 - 16 If Bit 12 if false, select one of 16 pre-
programmed automatic sequences (seven available
on Shuttle).
If Bit 12 if true, select serial channel track
number.

The eight operational modes are described below:

- Standby The unit is quiescent, powering only those
circuits necessary to recognize a nonstandby
mode command.

Record Serial A	Records digital data present at Input A in a serial track-switching format beginning on the commanded track and progressing to Track 14. If Track 0 is commanded, recording starts on the present track.
Record Serial B	Identical to Record Serial A except data are recorded from Input B.
Dump serial	Reproduces digital data in a serial track-switching format beginning on the commanded track. If Bit 4 is false, decrements toward Track 1 in the opposite direction from which data were recorded. If Bit 4 is true, increments toward Track 14 in the same direction in which data were recorded.
Loop	Records digital data present at Input A in a serial loop mode. Records on Tracks 12, 13, and 14 in a repeating loop sequence. When commanded to dump data in the loop mode via a special command bit, continues to record but dumps the most recently recorded data in the opposite direction from which they were recorded.
Record parallel	Records digital and/or analog data present at the input in a parallel format. The digital data input connector is used to identify the number of parallel digital channels to be recorded, while the analog data input connector identifies the number of analog channels to be recorded. Channel count is identified through hardwiring of a 4-bit binary number on the two data input connectors. Parallel recording is accomplished in the forward direction and continues until end of tape is reached. In addition to the parallel

	recording, digital data present at serial input A can be recorded simultaneously on any of the 14 channels not used for parallel data.
Dump parallel	Reproduces data on channels identified by input connector wiring. If data are analog, reproduce direction is forward, whereas digital data are reproduced in reverse. The serial digital reproduce channel may be used to dump digital data simultaneously on any channel during the parallel dump.
Stop	This mode is essentially the same as standby except that, if commanded by the primary interface, the unit is not receptive to any commands issued by the secondary interface. This mode allows the user of the primary interface to take control away from the user of the secondary interface.

Each of the eight operational modes discussed above, with the exception of loop, may be preprogrammed and executed as automatic sequences. An automatic stop or standby, although of questionable utility, may be commanded and can only be terminated with an interrupt command. When a serial mode, either record or dump, is executed as an automatic sequence, the sequence includes automatic tape positioning to the point of last serial recording on tape. This tape positioning eliminates the ability to record over previously recorded data and the need for bookkeeping, but it is not included when serial modes are executed via direct commands.

In addition to the six available programmable automatic sequences, a fixed automatic erase sequence is provided. This automatic mode erases the entire tape, clears all write protect mechanisms, leaves the tape positioned at beginning of tape, and switches the serial channel to Track 1. This mode is automatic and, once entered, can be terminated only by completion or by an automatic interrupt. To enter this mode, the command must be asserted for 10 seconds.

b. What Types of Payloads:

Automated, Automated with IUS, Spacelab

c. What STS Elements are Involved:

Orbiter,

d. Describe Interface Requirements:

Orbiter

PCM Unit

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

TBD

6. IDENTIFY ALL POTENTIAL USERS:

Potentially all NASA and Civil payloads if the payload recorder is not available for recording commands

Also DoD Payloads - DMSP, DSP, FSC, GPS (See Reference c)

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

TBD

8. EQUIPMENT COST ESTIMATE:

Non-recurring - None

Recurring - \$300,000/Unit

Development Schedule - TBD

9. POTENTIAL VALUE OF EQUIPMENT:

Recorder provided by payload or use orbiter recorder as available

10. STATUS:

Rockwell has a follow-on to their SSIS Study. The use of this item will be considered for further requirements study.

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. SAMSO TR-76-212-II-DoD Shuttle Integration Support Study, Final Report, Volume II, Avionic Summary, Rockwell International, November 1976.
- b. SAMSO TR-76-212-III - DoD Shuttle Integration Support Study, Final Report, Volume III, DoD/STS Avionics/Electrical Trades and Analysis, Rockwell International, November 1976.
- c. DoD Shuttle Integration Support Study, Final Briefing, 12th Technical Review, Integrated Payload/Shuttle Analysis Results, Rockwell International, 3 December 1976.

12. CONTACT: TBD

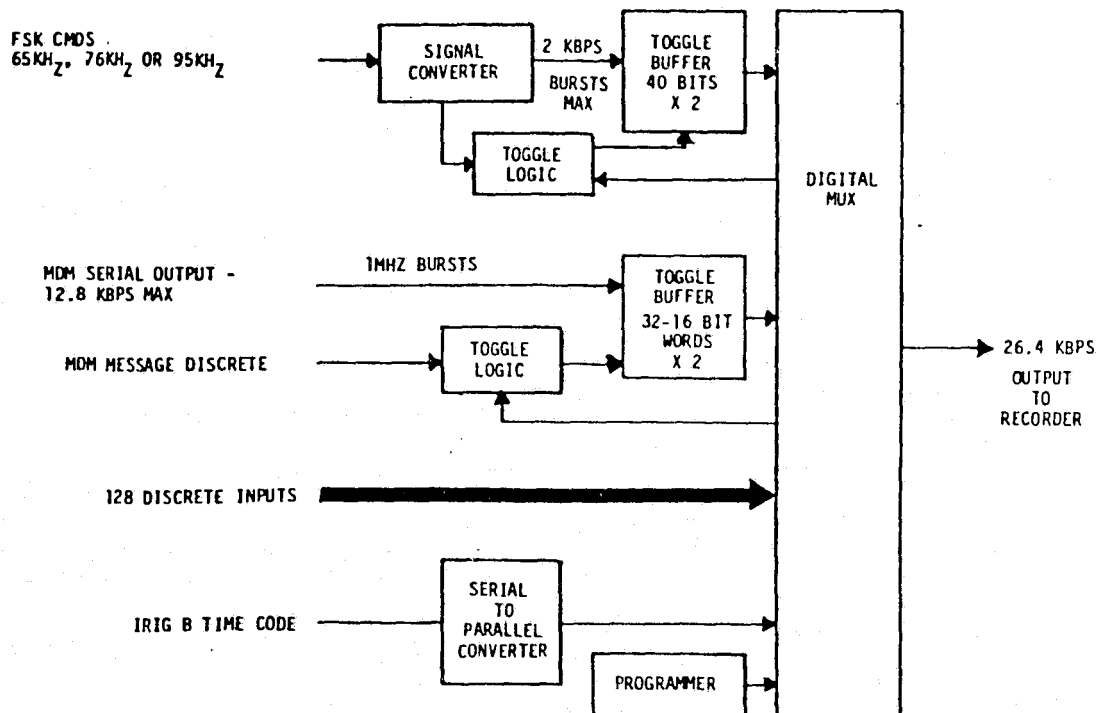
1. NAME OF ITEM AND IDENTIFYING NUMBER:

PCM Unit, No. TBD

2. EQUIPMENT DESCRIPTION:

The implementation for real time recording of commands originating in the orbiter currently does not exist. A requirement exists for recording, real time, all commands that directly affect payloads that originate in the orbiter. These commands include switch actions, keyboard-computer-originated commands, and guidance and navigation updates. In conjunction with the commands, recording a time tick of some type is required.

The recommended option was to combine all of the commands into a digital stream, using a new piece of equipment, a PCM unit, and recording this digital stream on the continuously running payload recorder. The unit consists of the necessary signal converters, a toggle buffer, a digital multiplexer, and a programmer. A block diagram of the PCM unit is shown in the figure.



3. PHYSICAL CHARACTERISTICS:

- a. Size: 5 x 10 x 5 Inches
- b. Weight: 20 Lbs

4. PURPOSE AND INTENDED APPLICATION:

a. Capability and Function:

The recording of orbiter-originated commands to payloads on a continuous running recorder requires that the switch action and command data be combined into a continuous PCM data stream. For this requirement to be met, a new piece of equipment is required on the orbiter - a PCM unit. The function of the PCM unit is to condition and interleave all command signals, discrete inputs, and IRIG B time code into a single serial PCM data stream for recording. The frequency shift keyed (FSK) command signals consist of three frequencies, 65 kHz, and 95 kHz, 50-percent amplitude-modulated with a 500-Hz or 1000-Hz triangular wave. The 500-Hz modulation envelope is used for commands with rates of 1000 bps, and the 1000-Hz modulation envelope is used for commands with rates of 2000 bps. A clock signal may be derived from this modulation envelope. Logic "one" and "zero" are represented by 95 kHz and 76 kHz, respectively. A space is represented by 65 kHz. A signal converter on the FSK input converts the FSK signal to an NRZ-L bit stream and loads the command data into a toggle buffer. This converter might consist of three two-pole filters with center frequencies located at 65 kHz, 76 kHz, and 95 kHz. Each would have a bandwidth of 4.2 kHz. The outputs from each would then be amplified and diode detected. The output from the diode detectors would be summed in a summing amplifier. The output of the summing amplifier would be put through a 500-Hz or a 1000-Hz filter, depending on the command rate. The bandwidth of the filter is 135 Hz. The output is put through a zero-crossing detector, which inputs to a monostable element to provide the clock output of 1000 Hz or 2000 Hz.

The outputs from each diode detector are individually compared in comparators. The outputs of the comparators are aligned with the derived clocked pulse. Decision logic is used to pick the one with the greatest amplitude. The output is four lines: S, 0, 1, and clock. Only one of the S, 0, or 1 lines will be high, the others low depending on the decision logic.

Several methods could be used to record the data. First the 1 line could be loaded into the FSK buffer. The derived clock would be used to read in the command. The read into the buffer would start when the S line goes low and would reset on an S high followed by a data bit. This method would provide a NRZ-L command in the PCM buffer. The command would appear in the PCM stream over and over again until a new command was sent. If it were desirable to differentiate between identical commands sent in sequence, a status bit might be added to the system to show presence of a command for the first time.

A second method that might be considered is to record all four lines. This would result in loading four buffers and reading them out at a higher rate. This method is less desirable since it uses up more space in the PCM stream. The advantage would lie in troubleshooting the command systems.

For commands from the multiplexer/demultiplexer, serial output is a 1-MHz serial digital stream that comes in bursts of up to 32 twenty-bit words. Sixteen bits of each word contain the command intelligence bits are stored in the toggle buffer to be time-delay-multiplexed by the digital multiplexer into the output data stream.

Toggle buffer operation ensures that data are multiplexed such that time homogeneity of the command words is preserved. The FSK S signal and the MDM message discrete provide an "end of message" logic for their respective toggle buffers, for each issued command. The PCM is programmed to obtain data from each toggle buffer at a greater rate than the data came in. The PCM unit will output zeros until an "end of message" signal indicates one side of the toggle buffer is loaded. When an "end of message" is received, the toggle will occur and the PCM will read out the loaded data. Since the PCM reads out faster than data are loaded, it will have read out one side of the toggle buffer faster than the other side is loaded. Another toggle will not occur until an "end of message" is received for the other side, and the PCM will output "zeros" until this occurs. The maximum data rate for the FSK signals is 2 kbps and the PCM readout rate for these signals is 2.4 kbps. The serial MDM output bursts are a maximum of 32 words in 40 milliseconds. The average intelligence data rate is a maximum of 12.8 kbps, and the readout rate by the PCM is 15.36 kbps. Thus, no data are lost by the PCM unit.

The IRIG B time signal is converted to a parallel format and sampled by the digital MUX 60 times per second. Thus time resolution is the PCM output is 1/60 second, even though time update in the IRIG B code is once per second. Discrete inputs are sampled directly by the digital MUX and time-division-multiplexed into the output data stream.

The sampling of the event (time window for an event) depends on how the event is instrumented. It would be expected that all switch actions would be instrumented real time and would be sampled at the PCM rate. In the case of the FSK signal, the toggle buffer will be loaded at the command rate and read out at the PCM rate. In the PCM shown, a 40-bit word would be recorded 60 times per second. Longer commands would require a revision of the PCM format and increased buffer sizes but would still be recorded 60 times. This should be more than adequate for the number of commands that can be sent per second to payloads. Discrete commands would probably show up as switch closures. If each one is designated a bit position in the PCM format, it would be sampled 60 times per second. The first time that a command or switch closure appears in the PCM stream would be within 1/60 second of the real-time event.

b. What Types of Payloads:

Automated, Automated with IUS, Spacelab

c. What STS Elements are Involved:

Orbiter

d. Describe Interface Requirements:

TBD

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

TBD

6. IDENTIFY ALL POTENTIAL USERS:

All NASA and Civil Payloads subject to commands that originate in Orbiter
Also DoD - DMSP, DSP, FSC, GPS (See Reference b)

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

1979-1981 TBD

1982-1991 TBD

8. EQUIPMENT COST ESTIMATE:

Non-recurring - \$2.5 Million

Recurring - \$100,000/Unit

Development Schedule - TBD

9. POTENTIAL VALUE OF EQUIPMENT:

Each program would provide required equipment

10. STATUS:

Rockwell International has a follow-on study to develop requirements

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. SAMSO TR-76-212-II, III, DoD Shuttle Integration Support Study, Final Report, Vols II, III, Nov 1976, Rockwell International
- b. DoD Shuttle Integration Support Study, Final Briefing, 12th Tech Review, Integrated Payload/Shuttle Analysis Results, 8 Dec 1976, Rockwell International

12. CONTACT: TBD

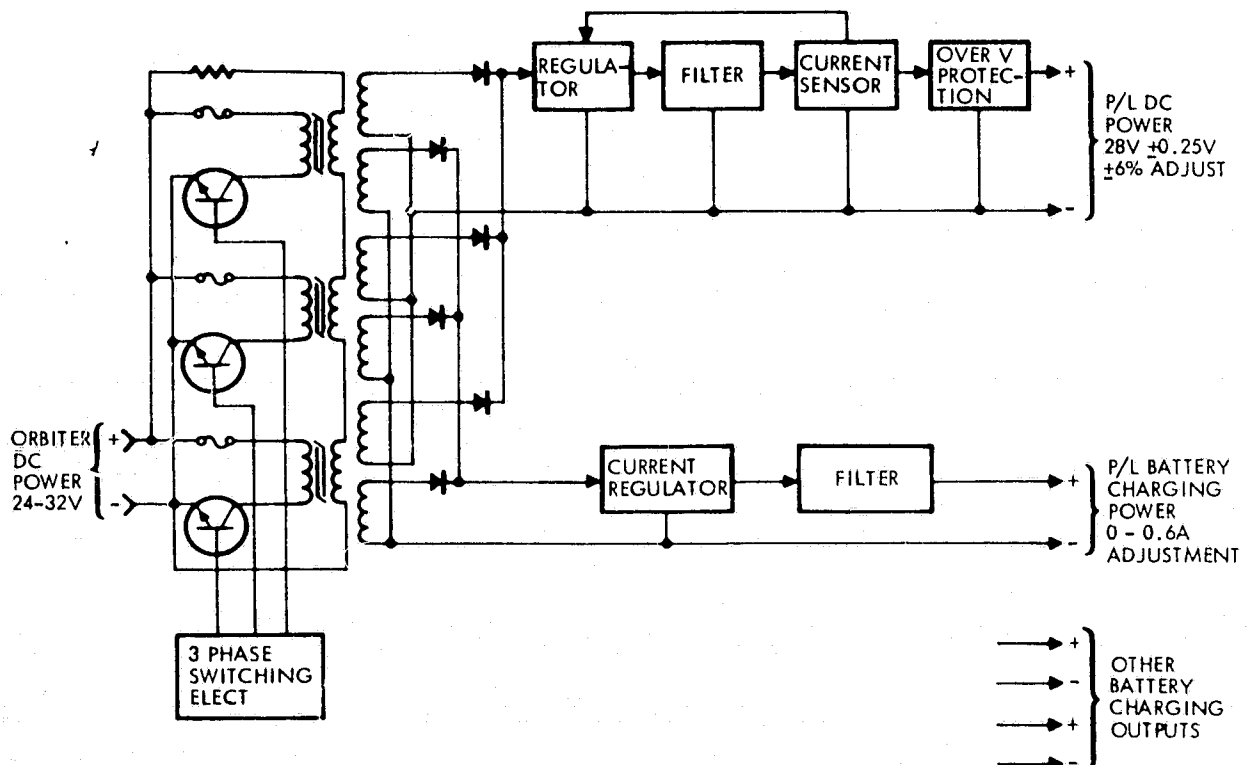
1. NAME OF ITEM AND IDENTIFYING NUMBER:

DC-DC Converter/Regulator, No. TBD

2. EQUIPMENT DESCRIPTION:

The orbiter power characteristics are defined in Specification MF0004-002. The power quality defined by this specification is incompatible with the power requirements of the four payloads used for this study. In addition, the orbiter utilizes the skin and structural members of the vehicle for the power return. The dc voltage between the positive orbiter bus and return varies from location to location. Moreover, these voltages are modulated by the power load profile.

Since the DOD payloads generally have a single-point ground system, it is therefore necessary to provide a single-point ground at each payload location. Each payload then must be powered by one separate isolated power supply. This will completely isolate the payload power from the orbiter power and permit the payload power return to be referenced to a single point on the orbiter. A block diagram for a DC-to-DC converter/regulator concept for supplying the required isolated and conditioned power to the payloads is shown in the figure below.



3. PHYSICAL CHARACTERISTICS:

- a. Size: 10 x 10 x 6
- b. Weight: 27 Lbs

4. PURPOSE AND INTENDED APPLICATION:

a. Capability and Function:

The requirements for a DC-DC converter/regulator are presented here:

Input Power

The input power is as follows:

Input voltage: 24 - 32 vdc

Power quality: Spec MF0004-02

Converter regulation efficiency: 70% min at 80% of full load

Conducted noise into orbiter bus: 3 amps PP or 0.4 v PP single frequency, 0.8 v PP all frequencies, whichever is lower

Internal short protection: Input fusing shall be provided

Output Power

Each dc-to-dc converter/regulator or isolated output associated with any one payload shall have one main dc output that provides power to the payload itself. In addition, several auxiliary outputs may be required for battery charging power and for auxiliary equipment required to isolate and condition signals between the orbiter and payload.

Main Output Power

The main output power is as follows:

Output power, full load: 500 watts

Output voltage: 28 v nominal, +6% adjustment

Regulation, steady state: ± 0.25 v
(Line plus load change 25% to 100%)

Regulation, transient: ± 4 volts
(Step change of 25% line or load)

Temperature coefficient: ± 15 mv/°C

Ripple and noise: TBD

Output current, full load: 18 amps

Overload current limit: Straight with time delay cutoff

Current limit adjustment: 40% to 125% of full load

Auxiliary Outputs

Battery Charging. The battery charging power is as follows:

Output voltage: 28 - 40 v

Output current: 0-0.6 amps (adjustable)

Regulation (current): $\pm 1\%$

Number of outputs: 3

Auxiliary Equipment. The auxiliary equipment needed is:

Number of outputs: TBD

Output voltages: TBD

Output current: TBD

Mechanical/Thermal

Mechanical/thermal requirements are as follows:

Size: 600 cubic inches

Weight: 26.6 lb

Input/output connectors: TBD

Mounting surface finish: TBD

Mounting area: 100 square inches

Thermal impedance: $0.05^{\circ}\text{C}/\text{watt}$

Cooling: Conduction from mounting surface

Non-operating mounting surface temperature: 20°C

Reliability

Mean Time Between Failure (MTBF)

The MTBF requirement, per MIL-HDBK-217B, 67 percent confidence factor, greater than 20,000 hours.

Component Selection

Component selection is as follows:

Standard parts: Per MF0004-400

Special parts: As required

b. What Types of Payloads:

Automated, Spacelab

c. What STS Elements are Involved:

Orbiter

d. Describe Interface Requirements:

Orbiter DC Power 24-32 V

5. IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:

TBD 1979-1980

6. IDENTIFY ALL POTENTIAL USERS:

NASA Astronomy as well as any Automated Payloads which require better voltage regulation than that provided by the STS

DoD - DMSP (See Reference b)

7. ESTIMATE FLIGHT RATE OR NUMBER REQUIRED:

TBD

8. EQUIPMENT COST ESTIMATE:

Non-recurring - \$265,000

Recurring - \$35,000/Unit

Development Schedule - TBD

9. POTENTIAL VALUE OF EQUIPMENT:

Payload programs will have to provide own conditioning equipment

10. STATUS:

Rockwell International has follow-on study to develop requirements

11. REFERENCE(S) FOR ADDITIONAL DATA:

- a. SAMSO TR-76-212-II, III, DoD Shuttle Integration Support Study, Final Report, Vols II, III, Nov 1976, Rockwell International
- b. DoD Shuttle Integration Support Study, Final Briefing, 12th Tech Review, Integrated Payload/Shuttle Analysis Results, 8 Dec 1976, Rockwell International

4. REFERENCES

1. STS Users Study (Study 2.2) Final Report, Volume III: Ancillary Equipment, The Aerospace Corporation, Report No. ATR-76(7362)-1, Vol. III (1 November 1975).
2. Schedules and Status Summary, Volume 2: Payload Integration, NASA KSC, Report No. KSC-K-SM-03.2 (15 October 1976).
3. Ancillary Equipment - MSFC Proposed - Set of Briefing Charts, NASA Marshall Space Flight Center (28 April 1976).
4. STS Facility and Equipment Requirements Documentation, Volume 3, NASA Kennedy Space Center, Report No. K-MMSEM-10.1.3, Revision 1 (3 January 1977).
5. Final Report, Multi-Use Mission Support Equipment (MMSE), Volume II, Book 1, Requirements, Definition, and Design Analysis, Martin Marietta Corporation, Report No. MCR-76-202 (June 1976).
6. Catalog - Multi-Use Mission Support Equipment (MMSE), Martin Marietta Corporation, Report No. MCR-76-202 (June 1976).
7. Final Report, Multi-Use Mission Support Equipment (MMSE), Volume II, Book 2: Appendix, Martin Marietta Corporation, Report No. MCR-76-202 (June 1976).
8. Catalog - Multi-Use Mission Support Equipment (Launch Site), Revision D, Martin Marietta Corporation (February 1976).
9. Shuttle Orbiter Mission Kit Status, Semiannual Report, Rockwell International, Report No. SD 76-SH-0251 (December 1976).
10. Use of STS Equipment (Subsystems/Components) for MMSE Final Briefing, Rockwell International, Report No. SD 75-SA-0182 (10 December 1975).
11. DoD Space Transportation System Payload Interface Support Study, Final Report, Books 1 and 2, McDonnell Douglas Astronautics Company, Report No. SAMSO-TR-76-103 (December 1976).

12. DoD Space Transportation System Payload Interface Support Study Final Report, Appendix I: Integration Equipment Requirements, McDonnell Douglas Astronautics Company, Report No. SAMSO-TR-76-103 (December 1976).
13. DoD Space Transportation System Payload Interface Support Study Final Report, Appendix E: Interface Verification Requirements, McDonnell Douglas Astronautics Company, Report No. SAMSO-TR-76-103 (December 1976).
14. DoD Shuttle Integration Support Study Final Report, Volume IV: DoD/STS Payload Installation Configurations, Rockwell International Space Division, Report No. SAMSO-TR-76-212-IV (November 1976).
15. DoD Shuttle Integration Support Study Final Report, Volume V: Structural-Mechanical Trades and Analysis, Rockwell International Space Division, Report No. SAMSO-TR-76-212-V (November 1976).
16. DoD Shuttle Integration Support Study Final Report, Volume XII: DoD/STS Mixed and Multiple Payload Analysis, Rockwell International Space Division, Report No. SAMSO-TR-76-212-XII (November 1976).
17. DoD Shuttle Integration Support Study Final Report, Volume III: DoD/STS Avionics/Electrical Trades and Analysis, Rockwell International Space Division, Report No. SAMSO-TR-76-212-III (November 1976).
18. DoD Shuttle Integration Support Study Final Report, Volume XIII: DoD-STP/STS Mixed Payload Considerations, Rockwell International Space Division, Report No. SAMSO-TR-76-212-XII (November 1976).
19. Payload Descriptions, Volume I: Automated Payloads, Level B Data (SSPD), NASA Marshall Space Flight Center (July 1975).
20. Payload Descriptions, Volume II: Sortie Payloads, Level B Data (SSPD), NASA Marshall Space Flight Center (July 1975).
21. Final Briefing, DoD Shuttle Integration Support Study, 12th Technical Review, Integrated Payload/Shuttle Analysis Results, Rockwell International Space Division (8 December 1976).
22. Final Report, Multi-Use Mission Support Equipment (MMSE), Executive Summary, Martin Marietta Corporation, Report No. MCR-76-202 (June 1976).
23. Final Report, Multi-Use Mission Support Equipment (MMSE), Volume III: Project Cost Estimates, Martin Marietta Corporation, Report No. MCR-76-202 (June 1976).

24. Final Review, Multi-Use Mission Support Equipment, Martin Marietta Corporation (May 1976).
25. Final Study Report, Payload Specialist Station Study, Volume I, II, III: Executive Summary, Martin Marietta Corporation, Report No. MCR-76-403 (November 1976).
26. Final Report, Payload Transportation Study, Martin Marietta Corporation, NASA Contract NAS 10-8902 (August 1976).
27. Catalog - Multi-Use Mission Support Equipment, Martin Marietta Corporation, Report No. MCR-75-229 (June 1975).
28. DoD Space Transportation System (STS) Payload Interface Study, Final Report, McDonnell Douglas Astronautics Company/TRW Systems Group, Report No. SAMSO-TR-73-280-Vol. II (October 1973).
29. DoD Space Transportation System (STS) Payload Interface Study, FY 74 Extension, Final Report, McDonnell Douglas Astronautics Company/TRW Systems Group, Report No. SAMSO-TR-74-198 (October 1974).
30. DoD Space Transportation System (STS) Payload Interface Study, FY 75 Extension, Final Report, McDonnell Douglas Astronautics Company/TRW Systems Group, Report No. SAMSO-TR-75-136 (May 1975).
31. DoD Space Transportation System Payload Interface Support Study, Interim Report, McDonnell Douglas Astronautics Company, Report No. MDC G 6367 (March 1976).
32. DoD Space Transportation System Payload Interface Support Study, Second Interim Report, McDonnell Douglas Astronautics Company, Report No. MDC G 6469 (August 1976).
33. DoD Space Transportation System Payload Interface Support Study, Appendix B, Thermal Analysis, McDonnell Douglas Astronautics Company, Report No. MDC G 6469 (August 1976).
34. DoD Space Transportation System Payload Interface Support Study, Appendix E, Interface Verification Requirements, McDonnell Douglas Astronautics Company, Report No. MDC G 6469 (August 1976).
35. DoD Space Transportation System Payload Interface Support Study, Appendix F, Transition Plan, McDonnell Douglas Astronautics Company, Report No. MDC G 4649 (August 1976).

36. DoD Space Transportation System Payload Interface Support Study, Appendix H, EMC Analysis, McDonnell Douglas Astronautics Company, Report No. MDC G 4649 (August 1976).
37. DoD Space Transportation System Payload Interface Support Study, Verification Equipment Concepts Summary, McDonnell Douglas Astronautics Company, Report No. MDC G 4619 (July 1976).
38. DoD Space Transportation System Payload Interface Support Study, Payload Verification Plans, McDonnell Douglas Astronautics Company, Report No. MDC G 6465 (November 1976).
39. DoD Space Transportation System Payload Interface Support Study, Midterm Briefing, McDonnell Douglas Astronautics Company, Report No. MDC G 6377 (8 April 1976).
40. Auxiliary Payload Power System Study, Task Report I, II, III, and IV, McDonnell Douglas Astronautics Company, NASA/MSFC Contract No. NAS8-31361 (1975).
41. Study of Methods of Providing Thermal Control for RTG's Used on NASA Payloads, Final Report, McDonnell Douglas Astronautics Company, JPL Contract No. 954094 (April 1975).
42. DoD Shuttle Integration Support Study, Mid-Term Overview, Rockwell International Space Division (April 1976).
43. Use of STS Subsystems and Components for MMSE Executive Summary, Volume I, Rockwell International, Report No. SD 75-SA-0181 (December 1975).
44. Space Shuttle System Summary, Rockwell International, Report No. SSV 76-32 (July 1976).
45. Shuttle Orbiter Ku-Band Radar/Communications Subsystem Bidders Seminar, Rockwell International, Report No. SSV 75-28 (13-14 August 1975).
46. DoD Shuttle Integration Support Study Final Report, Volume II: Avionic Interface Compatibility Study, Rockwell International Space Division, Report No. SAMSO-TR-76-212-II (November 1976).
47. Spacelab Utilization Study, Space Test Program, Mid-Term Briefing, TRW Systems Group, Report No. 8140.8.4-59 (20 August 1976).

48. STP Spacelab Utilization Study Final Report, TRW Systems Group, Report No. 30297-6001-RU-00 (15 November 1976).
49. Ku-Band Integrated Radar and Communication Equipment for the Space Shuttle Orbiter Vehicle - Conceptual Design Review, Hughes Aircraft Company (18-20 January 1977).
50. Spacelab Payload Accommodation Handbook, NASA/ESA (1976).
51. Low Cost Modular Spacecraft Description, NASA GSFC, No. X-700-75-140 (May 1975).
52. Induced Environment Contamination Monitor (IECM) - Draft Provided by H. Gangl, NASA Marshall Space Flight Center (8 April 1976).
53. Space Shuttle Manned Maneuvering Unit Program Review, NASA Johnson Space Center, Report No. NASA-S-76-3835 (September 1976).
54. Ancillary Equipment - JSC Proposed - Set of Briefing Charts, NASA Johnson Space Center (28 April 1976).
55. Annular Suspension Pointing System for Space Experiments and Predicted Accuracy, NASA TR 448.
56. IPS Specification, IPS-DS-SP-0001 (23 December 1976).